

# AGRICULTURAL ENGINEERING

MARCH • 1947

Application of Hydraulic Controls to  
Trailing Implements *E. W. Tanquary*

The Use of Supplemental Heat in the  
Barn Curing of Hay *P. T. Montfort*

The Value of Consulting Work in Agri-  
cultural Engineering *H. B. Walker*

Report on Mow-Drying Chopped and  
Long Alfalfa Hay *Roy B. Davis, Jr.*

Analysis of the Economics of Farm Freez-  
ing Equipment *Lenore E. Sater*

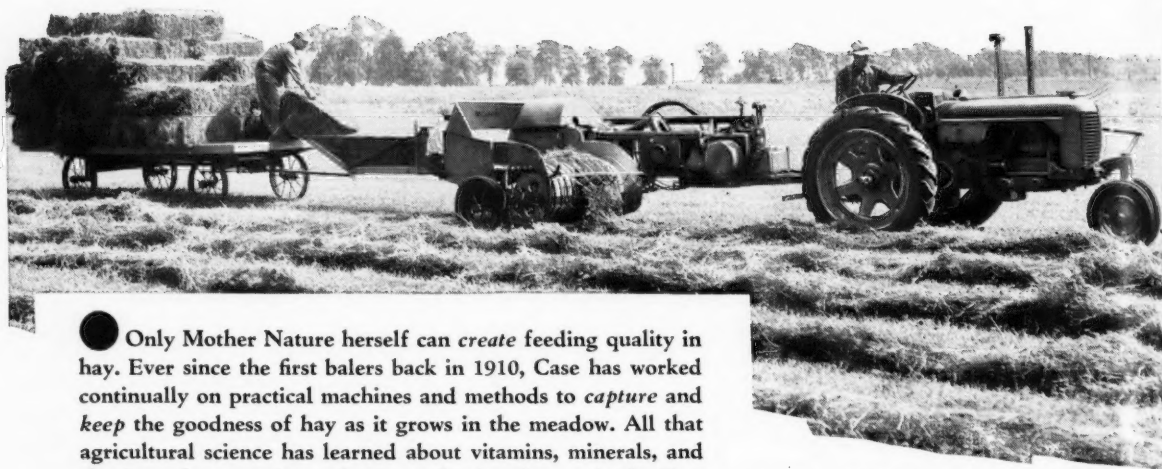


THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS



For **35** Years

*Blazing the Trail to Quality Hay*



● Only Mother Nature herself can *create* feeding quality in hay. Ever since the first balers back in 1910, Case has worked continually on practical machines and methods to *capture* and *keep* the goodness of hay as it grows in the meadow. All that agricultural science has learned about vitamins, minerals, and the time when protein reaches its peak, plays its part in the Case System of Making Hay.

Thus the Case Side-Delivery Rake, brought out when "tedding" was still done, turned directly away from that destructive practice. The Case rake made it possible to handle hay gently, to build high, fluffy windrows with leaves largely inside, sheltered from bleaching sun. It was the fast, work-saving way to Air-Conditioned Hay. The Case slow-gear, four-bar tractor rake of today does all this at modern rubber-tired speeds.

To get hay with all its leaves and quality from windrow to manger was another problem. Years of research and experience with big pick-up balers brought forth the Case Slicer-Baler. Slicing instead of stomping and folding saves leaves both in the field and in the manger or feed-lot. It is so simple that boys can operate it, so low in cost that most any farmer can own it, so swift that baling follows promptly in step with tractor-powered mowing and raking.

"HOW TO MAKE HIGH-PROTEIN HAY" is one of the Case educational booklets on advanced farm practices. Most of the subjects also have 16 mm. movies in full color and sound. Films are freely loaned, printed items freely furnished; send now for full list. J. I. Case Co., Racine, Wis.



**CASE**



The New Massey-Harris Self Propelled Corn Picker uses Link-Belt Silverlink Roller Chains, which contribute materially to its light draft and assure positive power transmission.

## LINK-BELT *Salutes* MASSEY-HARRIS!

A century of service to agriculture, marked by continuous advance in design and manufacturing methods, has made the name Massey-Harris well and favorably known throughout the world.

To the chorus of congratulations that arises from the entire industry, Link-Belt is proud to add this expression of sincere admiration for the many individual achievements, and particularly for the sustained policy of building high value into every Massey-Harris product. For over 60 years, Massey-Harris machines have employed genuine Link-Belt malleable iron and steel chains for the important functions of power transmission, conveying and elevating. Link-Belt screw conveyor is also used on the Massey-Harris Clipper Combine.

### LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5,  
San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8.  
Offices in Principal Cities.

10,821



# LINK-BELT

## *Chains and Sprockets*

FOR DRIVES...FOR CONVEYORS

# AGRICULTURAL ENGINEERING

Established 1920

## CONTENTS FOR MARCH, 1947

Vol. 28, No. 3

EDITORIAL .....	89
HYDRAULIC CONTROL FOR TRAILING IMPLEMENTS .....	91
<i>By E. W. Tanquary</i>	
SUPPLEMENTAL HEAT IN BARN HAY CURING .....	95
<i>By P. T. Montfort</i>	
REDUCING SURFACE SPOILAGE IN ENSILAGE .....	98
<i>By Ralph J. Anderson</i>	
GROUND WATER IN CALIFORNIA .....	99
<i>By C. N. Johnston</i>	
THE VALUE OF CONSULTING WORK FOR TEACHER DEVELOPMENT .....	100
<i>By H. B. Walker</i>	
QUALITY HAY DEFINED .....	103
<i>By C. B. Bender</i>	
MOW-DRYING CHOPPED AND LONG ALFALFA HAY .....	105
<i>By Roy B. Davis, Jr.</i>	
RADIANT HEATING FOR BROILER HOUSE .....	109
<i>By John B. Esbelman</i>	
ECONOMICS OF FARM FREEZERS .....	111
<i>By Lenore E. Sater</i>	
CONVERSION OF USED MILK COOLERS TO HOME FREEZERS .....	113
<i>By Thomas B. Tracy</i>	
RESEARCH NOTES .....	116
NEWS SECTION .....	118
PERSONNEL SERVICE BULLETIN .....	126

This Journal is owned, edited, and published monthly by the American Society of Agricultural Engineers.

Editorial and advertising departments at the executive office of the Society, Saint Joseph, Michigan. Publication office at Benton Harbor, Michigan.

### OFFICERS AND COUNCIL OF THE A.S.A.E.

MARK L. NICHOLS . . . *President*  
J. D. LONG . . . *Past-President*  
R. H. DRIFTMIER . . . *Past-President*  
C. N. HINKLE . . . *Councilor*  
P. T. MONTFORT . . . *Councilor*  
W. J. COULTAS . . . *Councilor*  
HENRY GIESE . . . *Councilor*  
F. E. PRICE . . . *Councilor*  
D. A. MILLIGAN . . . *Councilor*

RAYMOND OLNEY, *Secretary-Treasurer*  
RALPH A. PALMER, *Assistant Secretary*

SUBSCRIPTION PRICE: \$3.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to A.S.A.E. members anywhere, \$2.00 a year. Single copies (current), 30 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

The American Society of Agricultural Engineers is not responsible for statements and opinions advanced in its meetings or printed in its publications; they represent the views of the individuals to whom they are credited and are not binding on the society as a whole.

TITLE: The title AGRICULTURAL ENGINEERING is registered in the United States Patent Office.

COPYRIGHT: Copyright, 1947, by the American Society of Agricultural Engineers.

AGRICULTURAL ENGINEERING is a member of the Audit Bureau of Circulations.

Reprints may be made from this publication on condition that full credit be given AGRICULTURAL ENGINEERING and the author, and that date of publication be stated.

### ADVERTISING REPRESENTATIVES

Chicago, 2: DWIGHT H. EARLY  
100 North LaSalle St.  
Telephone: CENtral 2181

New York, 17: A. M. WILLCOX  
420 Lexington Ave.  
Tele: LEXington 2-4735

RAYMOND OLNEY  
*Editor and Business Manager*

## EDITORIAL

### Renaissance in China

**A**GRICULTURAL engineering's significance on a national scale seems due for demonstration and clarification in some of the current experiments in national development.

We are thinking particularly of China, as one of the several old civilizations, rich in undeveloped agricultural and mineral resources, in which world trade and the education of a comparatively small number of leaders has stimulated the urge for a renaissance.

As we understand the basic conditions involved in the static nature of some civilizations, physical and human forces have combined to balance the masses of population at a subsistence level of productivity and existence. Temporary gains in productivity, due to temporarily favorable conditions, have not been applied toward permanently increasing man's productive capacity because of a lack of incentive, means, know-how, or philosophy of production.

Considerable hope is now being placed on the thesis that outside influences can be introduced into the cycle sufficient to disturb the balance for the better; to start a cumulative, expanding cycle of productivity above the subsistence level. Influential leaders have arrived at the philosophy that their people can reach higher levels of material well-being and security only by productivity above current consumption, converted into tools of production, and applied to further increase productive capacity.

Increased efficiency in food production has been accepted as one logical starting point. Until thousands of individual families can easily produce enough food for themselves and for a few others, little time of few people can be devoted to other industries and services; to the development, production, and direction of additional high-efficiency production equipment; to training and work in the trades and professions by which productive efficiency and the physical means of living at higher levels of material welfare may be increased.

Agricultural engineering has been accepted as one of several important factors in accomplishing this initial and snowballing increase in efficiency of food production. Results of the parallel introduction and demonstration of improved hand tools, two-animal equipment, small tractor equipment, medium tractor equipment, and large tractor units should prove highly interesting. The greater potential efficiency of the larger units may be evident in China as elsewhere. Still, the lesser difficulty of getting improved hand tools into the hands of millions and into effective use by them may make hand tools temporarily the most important equipment aids in initiating increased efficiency in Chinese agriculture. In fact, a few million good hoes quick might get at the root of the problem in some other areas of food shortages and political tension.

Dr. J. B. Davidson and his co-workers and sponsors, along with other American and Chinese agricultural engineers who have worked or will work along the same lines, are to be congratulated on their opportunity to take an important part in initiating a renaissance in the vital and enduring civilization of China. There are bound to be major difficulties, disappointments, and setbacks, but we are confident that under their leadership this development will not be delayed by any lack of application of the agricultural engineering means at their disposal.

What would the Chinese do with increased material welfare? Would it be for their own good? Would it

help their civilization to survive for another five or ten thousand years? Anywhere in this world, material prosperity of large numbers is a comparatively new influence on the evolution of individuals and civilizations.

### Engineering Factors in Farm Costs

**A** RECENT trend in current farm work simplification projects has been called to our attention. It is a trend toward greater recognition of the opportunities to increase the effectiveness of farm labor by improved and increased use of power and special equipment. It provides occasion to re-emphasize the engineering in farm production operations.

New principles of engineering are not the primary requirement. The general quantitative relationships between time, mechanical power, hand labor, motions, space, investment cost, operating cost, output, unit costs, and similar items, as well worked out in industrial and farm management, have been commonly known to agricultural engineers, and supported by them in principle. The physical differences between farm operations and those in manufacturing and other highly engineered production industries, and their influence on the application of production engineering principles in agriculture, have been analyzed and understood by agricultural engineers perhaps as well as by any group. Agricultural engineers with the manufacturers and in public service have, in fact, given farmers some fairly accurate and useful rule-of-thumb guides to the selection, combination, and application of equipment and practices to increase over-all production efficiency.

But we have passed the stage in which rule-of-thumb guides will suffice. There is visible opportunity to improve economy by refinement in applications comparable in degree to the 0.001-inch and smaller tolerances in the fit of various farm equipment parts and the minute control of proportions in the metallurgy of materials for farm equipment construction.

There may be few farm operations in which control within a small fraction of an inch is significant, but there are numerous instances in which a small fraction of a cent is significant in the cost of producing a unit of quantity and quality value in farm products.

Appreciation of use requirements, machine capacities, operating losses, operating safety, maintenance, depreciation, obsolescence, and similar factors places agricultural engineers technically in a key position to help farmers get maximum use value out of the quality and capacity being built into farm operating equipment. It remains for agricultural engineers to balance their development of farm operating capital equipment with a corresponding engineering development of its application methods and use economics.

### Machine Sheds

**F**ARMERS are appreciating more and more the limitations of the blue sky canopy as a storage for farm equipment. A recent survey in 47 agricultural counties of one north central state indicates that farmers there intend to build more machine sheds than any other type of building. The preference is almost double that for any other one type of building.

Apparently the urging by both farm machinery and structures men through the years has been bolstered by recent object lessons in depreciation and maintenance at a time when it was difficult for farmers to replace, or repair, or do without some of the rusted relics in their barnyards.

# *California moves to Kansas*



*The Land Plane has jumped the mountains and come to Kansas!*

This native of California, developed to finish-level land with an accuracy unequalled by other types of leveling machines, is finding big and profitable jobs to do far beyond its home grounds.

And when it gets to its new location, the Land Plane finds itself hitched to the same power that helps it succeed so well for Pacific Coast owners: A "Caterpillar" Diesel Tractor.

The Diesel D8 shown belongs to Overton and Vesper, Jetmore, Kansas. It is pulling a 12' x 60' plane on a U. S. Soil Conservation Service project. (Similar outfits are

busy in Texas, Colorado, Nebraska, Missouri and other midwestern states.)



When the outfit completes this job, the field will be planed to a non-erosive level. No high spots to impede water flow. No low spots to make puddles. Water use will be more efficient. Land productivity and value will be greatly increased.

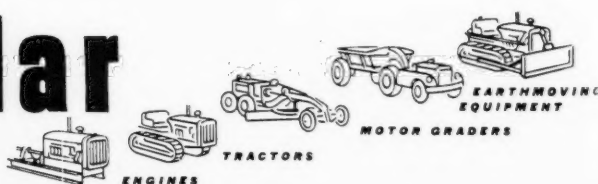
That's the way with ideas and equipment. Neither mental nor geographical barriers can quarantine their application—if their use is advantageous in other areas. That principle applies, with special significance, to "Caterpillar" Diesel Tractors, as well as to such tools as the Land Plane!

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

# Caterpillar

REG. U.S. PAT. OFF.

## DIESEL



# AGRICULTURAL ENGINEERING

VOL. 28

MARCH, 1947

No. 3

## Hydraulic Control for Trailing Implements

By E. W. Tanquary

MEMBER A.S.A.E.

THE application of hydraulic control to farm implements is familiar to agricultural engineers and some very good papers have been presented on the subject. I refer particularly to the papers, entitled "Hydraulic Controls for Farm Implements," by K. W. Anderson, and "Trends in Power Controls for Farm Machines," by W. A. Harper, both of which were published in AGRICULTURAL ENGINEERING for August, '46.

Mr. Harper discussed the proposed standardization of hydraulic cylinders for trailing implements which has been undertaken by the Advisory Engineering Committee of the Farm Equipment Institute. The value of such a standard to the farmer and to the agricultural industry as a whole is readily apparent, but two points that should not be overlooked are (1) the necessity of providing a safe and properly engineered application to the implement and (2) the importance to the farmer of furnishing cylinders for each model tractor of a diameter consistent with the capacity of the hydraulic system used with that tractor to operate at a satisfactory speed any make or model of trailing implement that may be used with a tractor of that drawbar horsepower rating.

I have been assigned to report on the progress made by the Advisory Engineering Committee on the development of the proposed standard, and it is not the intention to repeat any of the information presented in the papers just referred to, other than to review briefly the proposed standard and outline some of the problems encountered.

There are, however, two general types of hydraulic systems which must be considered in setting up the standard. The selective type, which produces a full cycle lift or lowering of the implement with each movement of the control lever and requires adjusting levers to provide graduated adjustment, is the system now in more general use. This system requires stops or limit control either on the cylinder or on implement to limit the range of movement to the desired operating depth.

Precision control which accomplishes a similar lift but with the position of the operating lever determining the relative position of the implement, while a more recent development, must also be taken into consideration. Stops or means

This paper was presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1946, as a contribution of the Power and Machinery Division.

E. W. TANQUARY is chairman, Advisory Engineering Committee, Farm Equipment Institute.

**AUTHOR'S ACKNOWLEDGMENT:** The author desires to give full credit to the special subcommittee—E. E. McCormick (chairman), Martin Ronning, and Gerald Geraldson—appointed to develop the proposed standard, as well as to contributions made by other members of the Advisory Engineering Committee.

of limiting operating depth are not required either on the operating ram or implement when a precision control system is used; but since the hydraulic cylinders are usually built into the tractor to operate an integral rockshaft for mounted implements, the maximum force available for transmission to trailing implements is that available at the arc transcribed by the rockshaft arm. Direction of application to the trailing implement is therefore important to insure that the greater force applied by the piston side of the cylinder to the rockshaft is made available to the greatest effort required to operate the implement.

In establishing the proposed standard the Committee determined that the problem should be broken down into sections: (1) for tractors under 35 dhp (drawbar horsepower) which includes tricycle-type and wheel-type tractors and implements for general farm use, and (2) a separate standard for tractors over 35 dhp which includes track-type and the larger wheel-type tractors and larger farm implements, including special tools such as scrapers, subsoilers, and blade levelers, more commonly used on the West Coast.

Reviewing briefly, the proposed standard for tractors under 35 dhp is as follows:

- Double-acting cylinders, 8-in stroke
- Cylinder length between pin centers, 20¼ in retracted, 28¼ in extended
- Yoke-type connections for each end of cylinder
- One-inch diameter attaching pins
- Cylinder located a maximum of 5 ft from the A.S.A.E. drawbar hitch point.

- Lifting time, 1½ to 2 sec

- Clearance area on implements to clear largest cylinder

Some of the items included in the standard, such as length of stroke and necessity for double-acting cylinders, have been developed and established to the approval of the Committee, but other points are still under investigation to determine the most satisfactory solution in consideration of application to the various types of implements.

Some of the problems encountered thus far are as follows:

**Lifting Requirements.** The table of lifting requirements for various sizes and types of implements, presented by Mr. Harper and listed in AGRICULTURAL ENGINEERING for August, 1946, was compiled from the best information obtainable from implement engineers at the time the Committee established the proposed standard. A great deal of effort has been expended in checking this data and additional information will be required before this table is



Adaptation of hydraulic control to a semimounted power mower

finalized. Progress is necessarily slow since engineering development of hydraulic systems for the various implements, as well as field testing, is involved; but the value of this information as a basis for tractor manufacturers to compute cylinder and pump capacities is recognized and the work of checking this table of lifting requirements will be continued.

**Stops for Selective-Type Systems.** The question of whether stops or limit control should be provided on the cylinder or on the implement has an important bearing on the eventual standard, since if one manufacturer provides the stops on the implement and not on the cylinder and another manufacturer provides stops on the cylinder but not on the implement, the tools without stops, if used with a cylinder without stops, would have no means of limiting the operating depth.

During the early development there was a preference by some engineers for stops on the implement, applied with a hand-adjusting screw which provided a finer and more convenient adjustment of the implement. Other engineers, who we must admit had more actual field experience, were using stops on the cylinder to avoid duplication on two or three pieces of equipment that might be purchased by one farmer. Due to direct application of the force against the stop on the cylinder, stops that will stand up under the maximum piston force can be applied to better advantage on the cylinder than on the implement.

The various types of implements are now being studied by the Committee to determine the most satisfactory application for stops, considering field operation as well as mechanical

construction. Present indications are that stops will be provided on the hydraulic control or cylinder and not on the implement.

**Direction of Application.** After location of the stops has been determined, the direction of application to the cylinder on the implement should be established. With the selective-type of system it is desirable to mount the cylinder so that the maximum piston force may be applied directly to the heaviest load. Thus, on a moldboard plow it would be desirable to mount the cylinder to push so as to avoid the loss of effective area from the piston rod.

With the precision control system, employing built-in cylinders and rockshaft, the cylinders are located to exert their maximum force forward to lift mounted implements. Application of this type of system to trailing implements can be accomplished by means of master and slave cylinders or push-pull cables direct to the rockshaft on the tractor and to the lift arm on the implement. It is apparent that with this type of application the maximum force available for transmission to the implement is that available from the rockshaft, and it is therefore necessary to employ the push-pull cable or slave cylinder to pull the greatest load, or in the instance cited, to pull for raising the plow.

There are other advantages of pulling to operate the greatest load. Buckling or weaving of the piston rod and subsequent wear on the bearing for the rod in the end of the cylinder can be eliminated and transfer of movement to the rear of the implements, such as disk plows, is simplified. The most direct application of the lifting force for moldboard

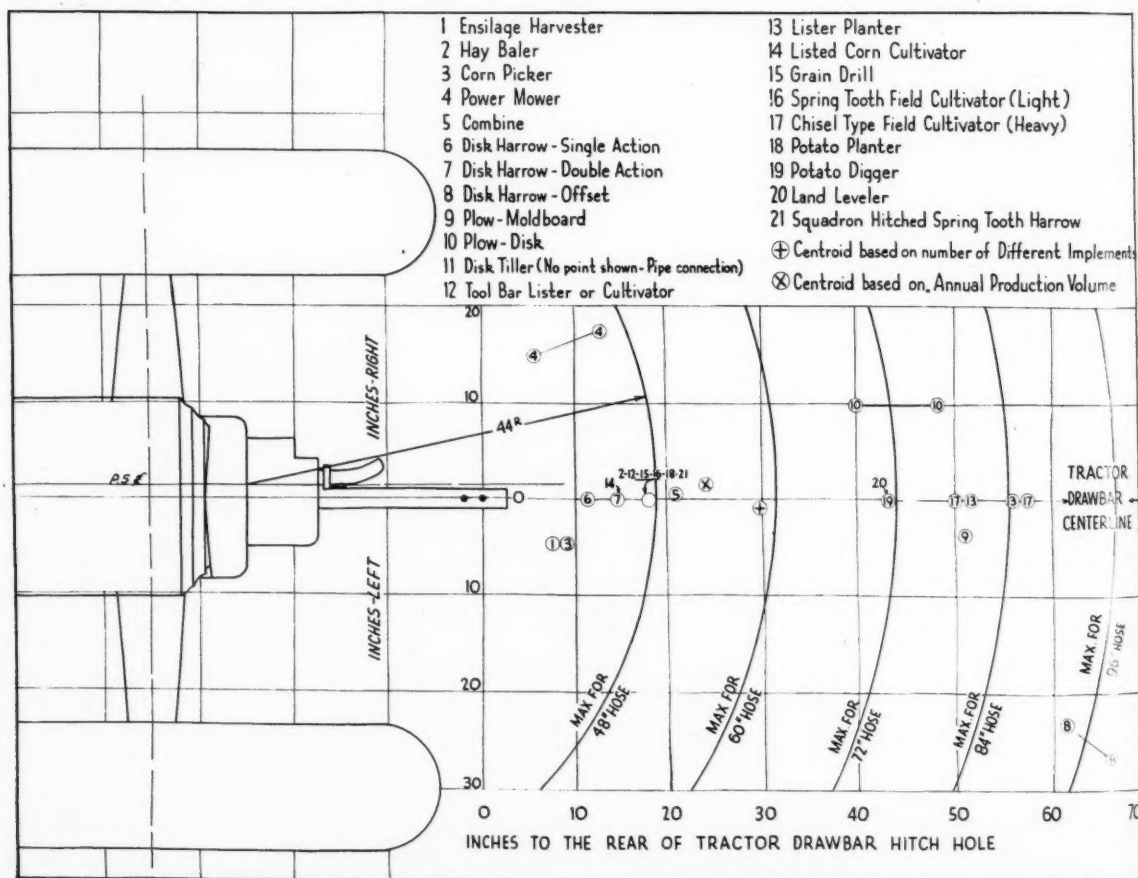


Fig. 1 Remote cylinder front hinge pin located on trailing implements—horizontal plane

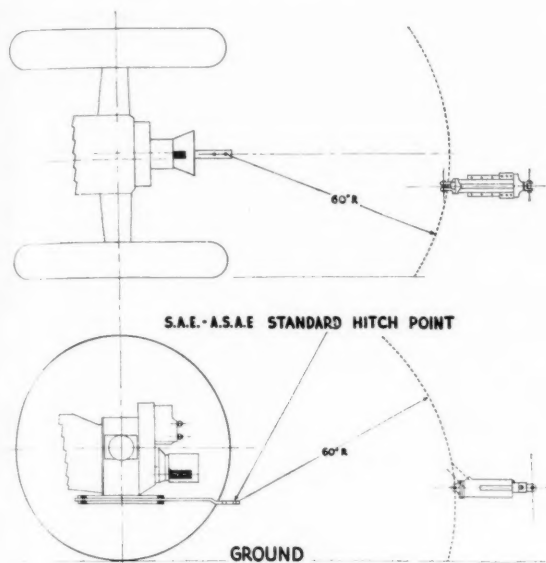


Fig. 3 A.S.A.E. standard hitch point location

plows and similar implements is to pull the arm, forcing a cranked axle down for lifting.

Yet, if we are to complete the objective of interchangeability, it is necessary to apply the maximum cylinder force in the same direction on all makes of implements of each type. This may be accomplished by using the cylinder as a pull type for the greatest load and increasing the cylinder diameter to compensate for the loss of the piston rod area or by using a reverse connection to the implement. Increasing cylinder diameter is not favored due to the added cost and greater lifting time required for the larger cylinder to function. This phase of the problem is now being studied by the Committee.

**Hose Length.** The subject of hose length has also been carefully studied as it has an important bearing on our ability to provide complete interchangeability and on the convenience to the farmer when changing the cylinder from one implement to another. Hydraulic hose, particularly double or twin types required for double-acting cylinders, is expensive and there is some loss of efficiency when a longer hose is used. Pipes or supplemental hose length could be used to permit locating the cylinder at the most advantageous point for lifting each type of implement, but this would involve disconnecting the cylinder, connecting the regular hose to the pipe or supplemental length, and then reattaching the cylinder, resulting in a plumbing job inconvenient for the farmer and definitely objectionable to the tractor engineer due to the dirt or foreign material likely to be introduced into the system each time the hose line is broken. The detrimental effect of foreign material in a

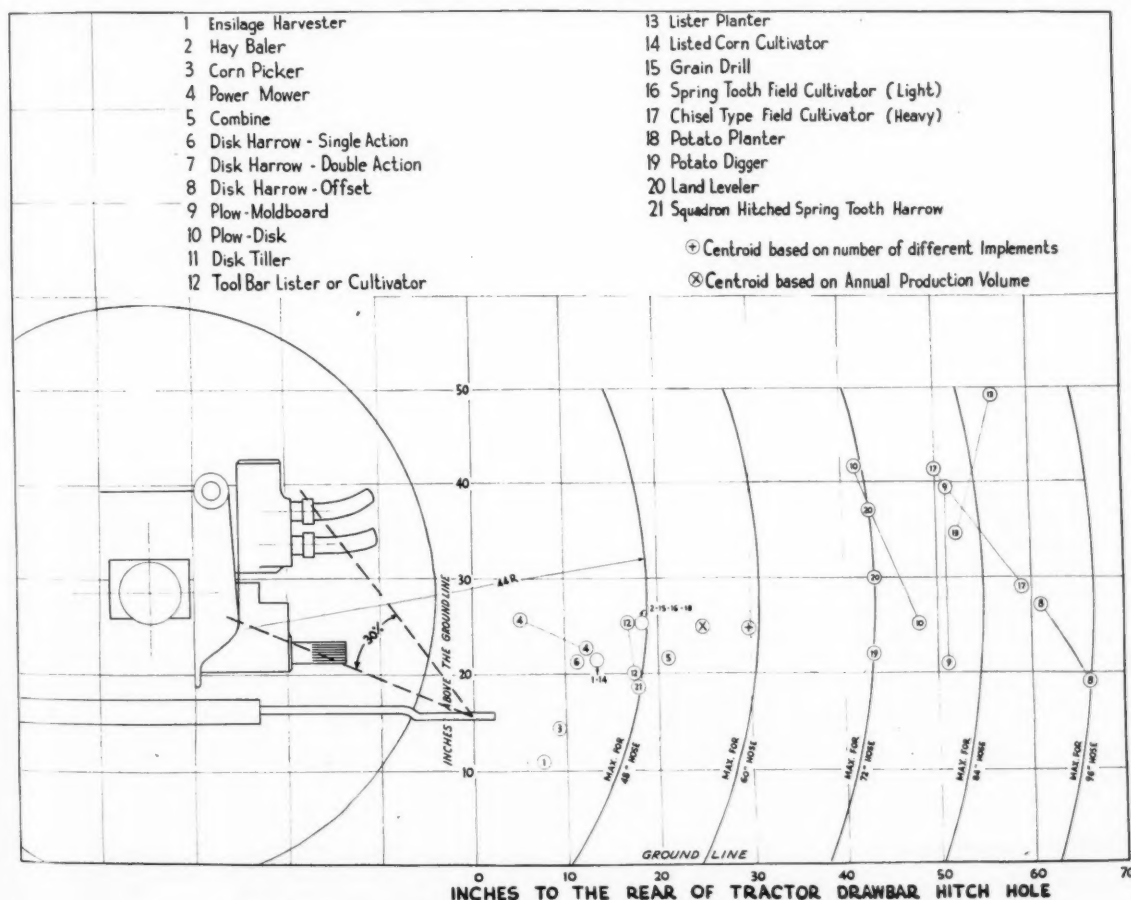


Fig. 2 Remote cylinder front hinge pin located on trailing implements—vertical plane

hydraulic system in impaired operation and shorter life of the pump is recognized, and the Committee has attempted to establish a hose length that will eliminate disconnecting the cylinder and the use of the supplemental hose.

Charts have been prepared by one company showing the desirable location of the cylinder on various types of implements. The exact location may not apply for all makes of implements, but the charts do illustrate the study made and other makes of implements will generally follow in the same pattern. Fig. 1 illustrates cylinder application in the horizontal plane. It will be noted that dimensions given, both fore and aft and lateral, are taken from the A.S.A.E. drawbar hitch point (Fig. 3). Hose length forward from the drawbar hitch point will vary with each model tractor, depending on the location of the hose outlet from the hydraulic system.

A mounting point 20 in from the drawbar hitch point would be suitable for implements with key numbers 1, 3, 6, 7, and 14 which, by referring to Fig. 1, includes ensilage harvesters, corn pickers, single and double-action disk harrows, and lister cultivators. Suitable location for the cylinder or other types of implements is indicated by the various key numbers and centroids established on the basis of the number of different implements and on the basis of annual production volume of the implements listed.

Fig. 2 illustrates cylinder application in the vertical plane with range of movement required for raising and lowering the implement. A variation of from 10 to 50 in above the ground line and a range of movement up to 17 in is indicated. Sufficient hose to allow for this range of movement and for shortening of the hose when operating over uneven ground and when turning must be allowed.

The radii showing implements that can be accommodated with hose of different lengths apply to the particular model tractor illustrated, after allowing for a 30 deg tilt for the front of the tractor when going over a knoll and the additional hose required from the drawbar hitch point to the tractor hydraulic system.

While a shorter hose would serve many implements, it is apparent from the chart that at least 52 in is required for the most popular implement (No. 9), a moldboard plow. Some additional length is required for action of a cushion spring hitch and operation over uneven ground. Results of this study led the Committee to establish the hose length to the following specifications:

Tractor manufacturers will provide sufficient length of hose so that the cylinder is operable when the front hinge

pin is located at a maximum of 60 in spherical radius whose center is the standard A.S.A.E. hitch point.

The implement manufacturer must locate the cylinder on his implement to provide allowances for cushion spring hitches, maneuverability, and turning so that the implement may be operated safely without stretching or breaking the hose under any circumstances.

**Tractors Over 35 dhp.** Application of hydraulic cylinders to subsoilers, scrapers, and similar tools in more common use on the West Coast has progressed further than applications to general farm implements, and there are a number of cylinders and implements already in production on which there exists considerable variation, particularly on length of stroke and location of the cylinder on the implement.

There is not a great deal of information available at this time in regard to lifting requirements, although it is apparent strokes longer than 8 in will be required, and one company has proposed a cylinder with 12-in stroke.

It may be necessary to provide cylinders with even longer stroke in order to accomplish the work effort required to lift some types of implements, and in other cases—an offset disk harrow, for example—to obtain the required action of the implement. There is, however, an advantage in adopting a shorter stroke, such as 12 in, if the desired action can be obtained, since operators of this specialized equipment will also want to use farm tools such as deep tillage plows and disk harrows with the same tractor and cylinder, and implement engineers would prefer to establish two mounting positions so that these larger implements can be used with tractors just under or over the 35 dhp division point.

Recognizing these problems, the Committee has appointed implement engineers from International Harvester, John Deere, and Allis-Chalmers West Coast plants to serve on the Committee and to develop their recommendations for a standard for tractors over 35 dhp.

When this portion of the program is more clearly defined the recommendation of the joint committee will be presented for consideration.

It is apparent that a great deal of time and effort has been expended in the progress thus far, and while additional work remains and progress is necessarily slow due to mechanical problems and to the range and variety of equipment involved, as well as the actual development and field testing required, I am confident the Committee's objectives can and will be reached.



POTATO AND SUGAR BEET HARVESTING MACHINE

These two views are of a new German potato and sugar beet harvesting machine developed by Hans Sack, a member of A.S.A.E. In tests made on it last fall, it picked up one ton of potatoes in seven minutes and loaded them into the wagon shown, which stood at the end of the field.

# Supplemental Heat in Barn Hay Curing

By P. T. Montfort

MEMBER A.S.A.E.

**I** NTEREST in farm-size hay curing equipment in Texas was first expressed by farmers in the southern part of the state, along the coast of the Gulf of Mexico. While soil and climate in this area are unusually favorable for the production of hay crops, it is almost impossible to harvest hay of high quality. Losses during the curing period are so great that all but a few of the more hardy individuals have discontinued hay production. Farmers in this region report that they normally expect total losses of 50 to 75 per cent with alfalfa and other legume crops due to rain and high humidity during the curing period. The hay that is saved is usually of inferior grade. Even the coarser hays, such as sudan and sargo, frequently rot in the field before they are sufficiently cured to be placed safely in storage.

Due to limited personnel, most of the investigational work in barn hay curing in Texas has been in the field with farmers who have requested assistance in designing, installing, and operating the equipment. This report, therefore, is based upon field observation of equipment operating under actual farm conditions, rather than carefully controlled laboratory experiments. The conclusions are based upon records collected from six installations during the past three years.

The first request for assistance in building and operating a barn hay-curing system was received in 1944. The decision to use supplemental heat was based on the following factors:

- 1 A careful study of weather conditions at three of our branch agricultural experiment stations in the area verified the general knowledge of unfavorable weather conditions for hay curing.

- 2 A number of farmers in the area had natural gas on the farm and butane was readily available at a reasonable price. Simple, inexpensive burners for these fuels were available locally.

- 3 Some experience had already been gained with air heating equipment in grain drying.

There are several distinct advantages in the use of heated air in the farm hay-curing system, as follows:

- 1 A better quality of hay with higher protein and vitamin

This paper was presented at the 3rd Barn Hay-Curing Conference sponsored by the American Society of Agricultural Engineers, at Chicago, Ill., December, 1946.

P. T. MONTFORT is research associate in agricultural engineering, A. and M. College of Texas.

content is produced because of (a) shorter precuring period in the field—less exposure to sun and rain, and (b) shorter curing time—smaller losses of protein and vitamin during curing

- 2 The capacity of the drier is increased because (a) several batches of hay can be dried during one cutting, and (b) depth of hay on the drier can be increased (for similar initial moisture content)

- 3 Hay can be dried regardless of weather conditions

- 4 Drier can be used effectively 24 hours per day

- 5 Equipment can be adapted to drying other crops, such as small grain, threshed milo, clover seed, corn, rice, and peanuts.

There are also several disadvantages to using supplemental heat in the hay curing system. The more important of these are (1) fire hazards, (2) higher first cost of equipment, and (3) higher cost of operation.

The fans are all of the multivane or centrifugal type. Four are forward-curve, double-inlet and two are back-curve, single inlet.

The six driers are located on the ground floor. The floor areas vary in size from 600 to 1500 sq ft. The widths vary from 12 to 20 ft, and the lengths from 40 to 100 ft. All of the air distribution systems are of the Tennessee type with the main header along one side. In three of the driers, the main header is divided at the center with provision for alternate blowing in each end of the system. The main headers in three of the systems are of concrete and located below the ground level with openings in the top to the laterals. The first of these underground headers was of uniform depth with the width tapered from the fan to the outer end. The later ones have a uniform width and the taper is provided by sloping the bottom of the header from the bottom of the fan outlet upward toward the outer end. This arrangement gives much more uniform distribution to the laterals. In five of the driers, the laterals are of the conventional wood construction with no taper. The other drier has a slatted subfloor on 6-in joists.

Both natural and butane gas are used for fuel. Low-pressure, injector-type industrial burners, which require no auxiliary air supply, have proven very satisfactory. The burners are installed directly in the air stream to the intake of the fan with no heat exchanger. The products of combustion combine with the air going into the drier.

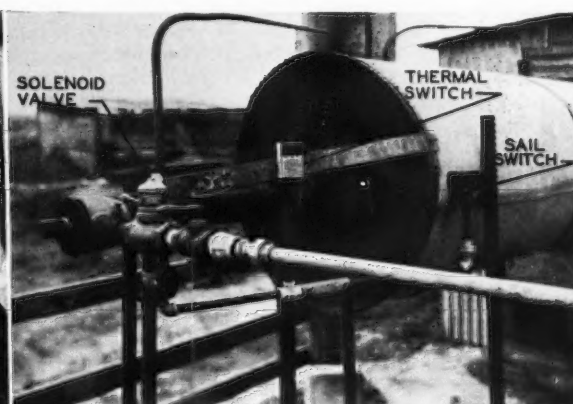


Fig. 1 (Left) Typical heater insulation for double inlet fan (and author himself) • Fig. 2 (Right) Burner and safety control assembly

If the fan is the single-inlet type with bearings on each end of the shaft, the intake is extended 6 to 8 ft with a sheet-metal tube. This prevents the open flame coming into direct contact with the bearing. The diameter of this tube should be not less than the diameter of the fan intake, or 2 ft, which ever is larger. The burner is located at the outer end of this tube, with the long axis of the flame in the center of the tube. If the fan is the single-inlet type, with both bearings on the pulley side, the metal intake tube is shortened to 2 to 4 ft, or in some cases eliminated entirely.

Double-inlet fans must be enclosed in a plenum chamber through which the heated air is drawn in order to prevent stratification and variation in temperature between different sections of the air distribution system. The hot air intake to this plenum chamber should, if possible, be located above and directly behind the fan.

Single-inlet fans are ordinarily available in the heavy-duty type only. These are considerably higher in first cost than the light-duty, double-inlet fans used in hay-curing systems. However, the first cost of the single-inlet fan is partially offset by the cost of the plenum chamber required with the double-inlet units. The installation of the single-inlet type is also much easier to make.

Other types of fuel, such as propane, gasoline, kerosene, distillate, fuel oil, coal, or wood, may be used for heating the air in a hay-curing system. When using any of these fuels, other than propane, it will probably be necessary to install a furnace or other form of heat exchanger so that the products of combustion are not carried through the drier. The selection of fuel to be used will be determined by availability, cost (Table 1), and the cost of the heater installation.

With any type of open-flame or furnace heating system, there is inevitably a certain fire hazard; however, if proper safeguards are maintained, the risk should be very slight. The three most likely fire hazards involved in the use of an open gas flame in a curing system are as follows:

- 1 Danger of the fan being damaged by heat in case the belt should break, or if the motor should stop because of overload or momentary power interruption

- 2 The possibility of momentary interruption of the gas flow which would cause the flame to go out. The fan would then pump raw gas through the drier. In the case of butane, this might settle to the ground and cause a serious fire hazard

- 3 Danger of dry leaves, bits of paper, trash, or other light, dry material being sucked into the open flame, ignited, and blown into the drier.

The danger from fan stoppage or flame failure can be overcome by the use of simple, inexpensive, semiautomatic controls. These controls consist of a solenoid valve in the gas supply line connected to a thermal element located in the burner flame, and a "sail" switch located in the fan intake. During normal operation, the solenoid valve is held in the "open" position by the magnetic coil. If the burner should go out, the thermal element cools and breaks the electric circuit to the solenoid. A spring then automatically closes the valve.

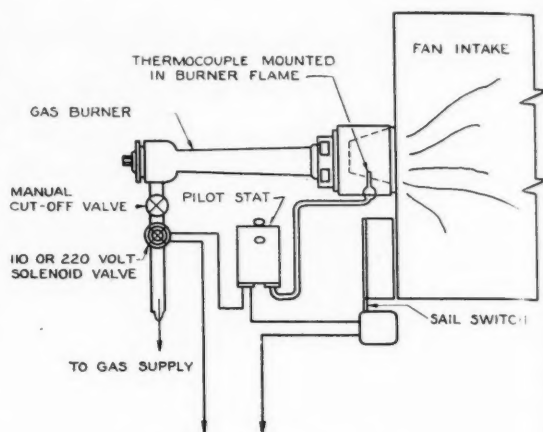


FIG. 3 Schematic diagram of semiautomatic safety controls

If the fan should stop, the sail switch breaks the circuit and the solenoid valve cuts off the gas supply. If the electric circuit controlling the operation of the solenoid originates on the motor side of the motor control switch, double protection is provided against danger from motor stoppage. These controls must be reset by the operator.

The total cost of the semiautomatic protective system will vary from \$25 to \$35, depending upon the size of solenoid valve required. A complete automatic temperature and flame control can be installed for \$125 to \$150.

Careful tests have demonstrated that there is very little danger from fire caused by particles of trash being drawn into the open flame. The velocity of the air passing the flame is so great that the material being carried in the air stream does not remain in contact with the flame long enough to ignite. Even lint cotton failed to ignite when introduced into the air stream over the flame. A hardware cloth (with  $\frac{1}{4}$  to  $\frac{1}{2}$ -in mesh) should be installed over the intake to prevent such foreign material entering the intake and fouling the fan wheel.

The use of heated air in the farm hay-curing system increases the rate of drying in three ways:

- 1 It increases the moisture carrying capacity of the air
- 2 When the hay is heated, the rate of diffusion of moisture from the interior of the stem or leaf to surface increases
- 3 The vapor pressure of the moisture on the surface of the hay is increased. This increases the rate of evaporation.

The rate of moisture removal from hay in a farm curing system will depend upon (1) temperature and relative humidity of the drying air, (2) the velocity of the air through the hay, (3) the size of the hay particles, and (4) the rate of diffusion of the moisture within the hay to the surface.

Air at 70F and 50 per cent relative humidity contains 4.05 grains of moisture per cubic foot. Air at 70F and 100 per cent relative humidity contains 8.09 grains of moisture per cubic foot. Thus air at 70F and 50 per cent relative humidity is capable of absorbing 4.04 grains of moisture per cubic foot if the temperature remains constant. If air at 70F and 50 per cent relative humidity is heated 100F, it will contain 3.83 grains of moisture per cubic foot and the per cent saturation will be 18.34. If the temperature is held constant at 100F and the air is saturated, it will contain 20.01 grains of moisture and will have absorbed 16.21 grains per cubic foot. Thus by heating the air 30F, its moisture absorbing capacity has been multiplied by four. If the same air is heated to 200F, the saturated mixture will contain 208.1 grains per cubic foot

TABLE 1. COMPARATIVE COSTS OF FUELS

Fuel	Heat of combustion, Btu	Cost*	Heater efficiency, per cent	Cost per million Btu effective heat
Natural gas	1,000 per cu ft	\$ .40 per 1000 cu ft	90	\$ .44
Butane	103,000 per gal	.09 per gal	90	.97
Propane	91,000 per gal	.33 per gal	90	4.03
Gasoline	117,000 per gal	.11 per gal	80	1.18
Kerosene	144,000 per gal	.09 per gal	80	.78
Fuel oil, No. 2	140,000 per gal	.09 per gal	80	.80
Fuel oil, No. 6	150,000 per gal	.09 per gal	85	.71
Coal	13,000 per lb	18.00 per ton	55	1.26
Wood	8,000 per lb	7.50 per cord	30	.87

\*Prevailing prices to farmers in Brazos County, Texas, December 1, 1946.

TABLE 2. WATER REMOVED IN DRYING HAY

Moisture content, per cent (wet basis)		Pounds water removed per ton dry hay
Beginning	End	
80	20	6000
65	20	2570
60	20	2000
50	20	1200
45	20	910
80	10	7000
65	10	3140
60	10	2500
50	10	1600
45	10	1270

and the moisture absorbing capacity will have been multiplied by approximately 51.

When designing a hay-curing system, it must be kept in mind that this apparent increase in moisture-carrying capacity of the air cannot be realized in practice. As the air passes through the hay some of the heat is transferred to the hay as sensible heat to raise or maintain the temperature of the mass. Approximately 1500 Btu is required to raise the temperature of a ton of hay containing 65 per cent moisture 1F. Additional heat is given up by the air in evaporating water. As a result, the temperature is lowered as the moisture content increases. The temperature of a cubic foot of air is lowered approximately 8½ F for each grain of moisture it absorbs.

If air enters the hay at 70F and 50 per cent relative humidity and leaves the hay fully saturated, the temperature will drop to 58F. It will have gained approximately 0.199 lb of moisture per 1,000 cu ft of air. If the same air is heated to 100F before entering the hay and leaves the hay at 100 per cent saturation, the temperature will be reduced to 68F. It will have gained 0.536 lb of water per 1,000 cu ft. The increase in moisture removal due to heating the air 30F is 0.337 lb per thousand cubic feet, or approximately 169 per cent. If the same air is heated to 200F before entering the hay and leaves the hay fully saturated, the temperature will be reduced to 92F. It will have gained 1.81 lb of moisture per 1,000 cu ft of air from the hay. This is an increase of 810 per cent above that removed by air entering the hay at 70F and 50 per cent relative humidity.

When drying any type of product, the smaller the particle, the faster it can be dried. As the particles are reduced in size, the total surface area exposed to the air increases and the distance the moisture must travel through the product is reduced. There is proportionately more surface exposed to the air with alfalfa and other legumes than with the coarser hays, such as sweet sudan and sargo. Chopping the hay not only increases the surface area exposed to the air, but it increases the possible rate of drying because moisture can be removed more

easily through the ends of the stems than through the walls. The length of cut may, however, be limited by the effect on palatability, or by the method of handling the hay.

In most cases the volume of air will need to be increased when the drying air is heated. This will be necessary to carry away the moisture without condensation occurring in the upper section of the hay mass. The increase in air velocity thus created will increase the rate of moisture evaporation from the surface of the hay.

The cost of fuel and power for drying hay will vary with the initial moisture content of the hay when it is placed on the drier, the moisture content at the end of the drying period, and atmospheric temperature and relative humidity during the drying period. The amount of moisture removed from the hay is the primary factor involved. Most hay crops when first cut contain 75 to 82 per cent moisture. If this hay is placed directly on the drier and reduced to a moisture content of 10 per cent, it is necessary to evaporate approximately 7000 lb of water for each ton of dry hay. If the hay can be predried in the field to a moisture content of 60 per cent, it will be necessary to remove only 2500 lb of moisture. If predrying continues until the hay has only 45 per cent moisture, it will be necessary to remove only 1270 lb of water per ton of dry hay.

On a clear day with air at an average of 78F and 70 per cent relative humidity, alfalfa will dry from 80 per cent moisture to 60 per cent within four to five hours.

At one installation in Texas alfalfa was chopped and placed on the drier immediately after it was cut. It was dried from 78 per cent moisture to 7 per cent. The cost of fuel and power was \$6 per ton of dry hay. At another installation the long alfalfa was placed on the drier at 60 per cent moisture and dried to 12 per cent. The cost of power and fuel in this case was reported at \$2.20 per ton of dry hay.

Alfalfa with small stems and a high percentage of leaves when dried directly from the field will produce a very high quality hay, often testing 19½ to 20 per cent protein and 140 to 150 parts of raw carotene per million. (Commercially dehydrated alfalfa usually contains about the same amount of protein and 240 to 250 parts raw carotene per million.) If similar hay is predried in the field to 60 per cent within a few hours, and with no damage from rain or dew, the resulting hay will still be of excellent quality. The protein content may be reduced one-half to one per cent. Carotene content, however, will be only about one-third that of the hay dried immediately after it is cut. If the hay is to be sold immediately, that with the high carotene content will usually bring a premium sufficient to justify the additional cost of drying. If the hay is to be stored and used on the farm, there is no advantage to the high carotene product since most of the carotene will be lost within a few months.

The savings in operating cost and drying time through the predrying period must be balanced against the probability of losses during the predrying period from bleaching, rain, and dew. This predrying period will vary with weather conditions and type of hay. For most areas, it will be practical to predry alfalfa to at least 60 to 65 per cent moisture before it is placed on the drier. The coarser hays, such as sweet sudan, dry very slowly. In the coastal area of Texas this type of hay may require one to two weeks to dry to 60 per cent moisture, even if left in the swath.

(Continued on page 108)

TABLE 3. RESULTS OF DRYING HAY WITH HEATED AIR  
(From observations at six installations in South Texas, 1944 to 1946, inclusive)

Kind of hay	Form	Moisture content per cent (wet basis)		Volume of air (cu ft/sq ft of floor area)	Temperature increase, F	Drying time, hr	Cost per ton (dry)*
		Beginning	End				
Sargo	Long	65	22	10	32	123†	\$2.24
Peanut	Long	55	11	10	35	70	2.67
Hegari	Bundles‡	53	22	9½	37	90	1.77
Alfalfa	Long	60	12	15	50	30	2.20
Alfalfa	Chopped (3 in)	78	7	25	90	36	6.00**
Cowpea	Chopped (3 in)	80	10	35	100	24	4.50††
Hegari	Chopped (1½ in)	72	8	10	80	92	2.42††
Hegari	Chopped (1½ in)	70	9	25	100	20	2.80††
Hegari	Chopped (½ in)	70	10	30	100	12	2.65††

\*Power and fuel: electricity at 3c per kw-hr and butane at 9c per gal.

†Fan operated during the day only; burner operated only 61 hr.

‡With heads.

\*\*Natural gas at 50c per 1,000 cu ft.

††Natural gas at 30c per 1,000 cu ft.

## Reducing Surface Spoilage in Ensilage

By Ralph J. Anderson

ASSOCIATE MEMBER A.S.A.E.

**M**ANY farmers and ranchers accept surface spoilage of ensilage as an agricultural burden, most of which can be lightened by sealing in the ensilage at the surface with wide widths of fiber re-enforced waterproof paper.

To reduce surface spoilage in permanent silos it is essential that the silage be well tramped and leveled. A level surface facilitates holding the paper snugly to the ensilage. Since most of the spoilage occurs at the walls, a good job of folding the fiber re-enforced waterproof paper to the wall (Fig. 1) will eliminate most of the waste at this vulnerable point.

At the walls the paper should be lapped 12 in, and where joints are needed another 12-in lap is necessary. Sufficient

ensilage or other heavy material should be placed on top of the paper at joints and edges in order to hold the paper firmly in position. It is not necessary to cover the entire surface of the paper; only the edges and laps. Enough weight is needed so that the paper will settle with the ensilage. In permanent silos that have no roofs, a little more weight is perhaps needed due to the possibility of wind damage.

In some parts of the country a good many cattle feeders and dairy farmers use trench silos. The same method used for eliminating ensilage waste in permanent silos can be applied to trench silos.

One of the weaknesses of storing ensilage in trenches has been the excessive surface spoilage. Another is the labor involved in removing this spoilage. For these two reasons many farmers have discontinued using trench silos. Some users have placed 6 to 12 in of soil on top of the silage. Wide widths of fiber re-enforced paper will save the labor involved in the handling of this heavy layer of earth seal. Morton Brothers of Lebanon, Indiana, tried using this paper in 1945 for the

This paper was prepared expressly for AGRICULTURAL ENGINEERING. RALPH J. ANDERSON is manager, farm department, The Sisalkraft Co., Chicago, Ill.

**AUTHOR'S ACKNOWLEDGMENT:** The author is indebted to I. D. Mayer, agricultural engineer, Purdue University Agricultural Experiment Station, for his cooperation and advice in connection with studies reported in this paper.

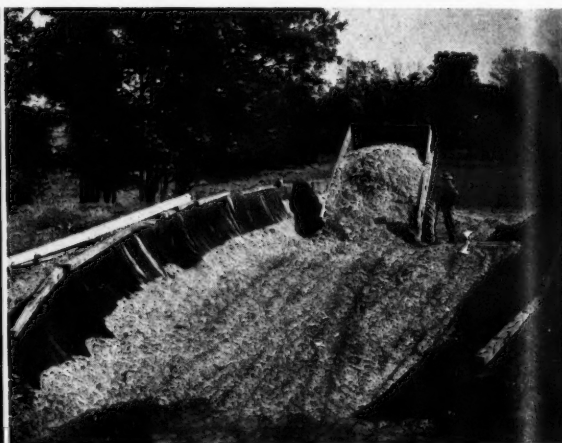


Fig. 1 (Upper left) A good job of folding the fiber re-enforced waterproof paper (Sisalkraft) to the wall of a permanent silo will eliminate most of the waste ensilage at this point. I. D. (Jimmie) Mayer, agricultural engineer of Purdue University, is the man doing the folding • Fig. 2 (Upper right) This picture shows the process of filling one of the Morton Brothers trench silos. Note layer of baled straw and lining of Sisalkraft at the edges of the trench • Fig. 3 (Lower left) This shows a trench silo covered with 13½-ft Sisalkraft. Note the double layer of the paper at the edges • Fig. 4 (Lower right) The end of this trench silo is sealed with a three-layer wall of baled straw, and this wall is in turn lined with Sisalkraft

conservation of ensilage in their trench silos. One silo was covered, and another was left uncovered for comparison. The capacity of these silos was about 600 tons each. They were filled with corn ensilage in September, and the uncovered trench silo was fed out of first. They started feeding out of the covered silo about January first. Widths of 13½ ft of the fiber re-enforced paper were used for the surface covering. A 12-in. allowance was used at the edges and laps and a layer of soil was placed over them. Morton Brothers estimate from 60 to 70 tons of ensilage as lost in the uncovered silo.

For added capacity Morton Brothers have always used a layer of baled straw at the edges of the trench (Fig. 2). These straw bales are lined with 36 in. of the fiber re-enforced paper, and the paper is brought up over the top of the bales about 12 in., to provide for laps. The cover is then brought down over this lap so that there are two layers of the paper at the edges. Most of the spoilage in trench silos, we understand, occurs at the edges, and this method allows for double protection.

Fig. 2 also shows dump trucks used to haul the chopped ensilage from the field. They are driven across the length of the silo and thus help to do a good job of packing.

Fig. 3 shows the application of the 13½-ft width of fiber re-enforced paper to the ensilage. It will be noted that the paper is held in position by the application of soil at the edges and laps only. The picture also shows the double layer of re-enforced paper at the edges as mentioned above.

Fig. 4 shows how the end of the trench silo is sealed. The three-layer wall of baled straw used for end sealing is also lined with the fiber re-enforced paper, as this is another vulnerable spot where a good deal of spoilage is found.

#### SURFACE SPOILAGE IN TRENCH SILOS

In 1945 and again in 1946 the surface spoilage in Morton Brothers trench silos, under the fiber paper covers was considered nil. Howard Hill, of Minburn, Iowa, covered his trench silos in 1945 and 1946 with the same results.

We know of at least fifty farmers in Iowa, Indiana, Illinois, and Nebraska who in 1946 used fiber re-enforced paper to cover their trench silos. We have been in touch with most of them and they are well satisfied. The spoilage has been held to a minimum, and the consensus of these farmers is that \$40 to \$50 worth of the fiber paper will save \$250 to \$300 in feed alone. These figures incidentally, do not include the cost of labor involved in handling the spoiled ensilage.

We also know of about fifty farmers who are covering ensilage in their permanent silos with our paper, and they are all well satisfied. In all cases surface spoilage has been held to a minimum.

This is an ideal use for our fiber re-enforced paper because it can be handled without tearing. Also, a man can walk and kneel on it, and the wide widths eliminate a good many of the laps, thereby increasing the efficiency of application. The 84-in or 13½-ft widths are ideal for this use.

Careful handling of the paper should enable the farmer to salvage a good deal of it for reuse.

I would like to emphasize the importance of doing a good job of compacting and leveling the ensilage in permanent silos before covering with the paper. There should be no crowning. Fig. 1 shows an ideal covering job.

For covering trench silos, a good job of compacting the ensilage is again desirable. However, all of our cooperators are using a crown for surface drainage (Fig. 3).

Our research work in the application of fiber re-enforced waterproof paper to covering ensilage in trench and permanent silos is not yet complete, we feel safe in saying that the paper will perform satisfactorily from fall to early spring in most parts of the country.

## Ground Water in California

By C. N. Johnston

MEMBER A.S.A.E.

GROUND water in California is in a status unlike that of the weather described by Mark Twain because here and there we are able to do something about it. This state has one main large north-south valley trough that slopes from the north near Mount Shasta to the vicinity of San Francisco and from the south in the vicinity of Bakersfield also toward San Francisco. Into these two basins, comprising the great trough, feed the many streams out of the Sierras situated to the east and those from the Coast Range located in the west. Each stream has an individual alluvial cone near its entrance into the main valley. The latter is now the composite product of the alluvial fans from these streams, the accumulation since prehistoric times. The prehistoric streams left debris cones higher up on the mountain flanks, often above the beds of the present streams. The gravelly extensions of those early cones plunge below the present streams and sweep outward and downward into the great valley, forming the aquifers that furnish irrigation supplies to large areas of the state.

Because the prehistoric gravel layers are crossed normally somewhere in the path of present streams, infiltration in these crossings becomes an important source of supply for the underground strata that are tapped at lower elevations by pumping plants. Since the supply enters at a considerably higher elevation than the pumping area, and because the gravels are at some depth in these pumping areas, and also because the leakage from the water aquifers is slow, it is the exceptional well drilled in the state that has no hydrostatic pressure in the supply stratum or strata and is thereby non-artesian in character.

#### IRRIGATION DEMAND RAPID IN SOME AREAS

Agricultural developments are more intense in some areas of the state than in others due to markets, thrift of crops, and, more particularly, quality of soil. In some such areas the demand for irrigation water becomes more rapid than natural infiltration and transportation processes supply. The result is, first, a lowering of local water tables which permits greater transportation rates and, second, an overdraught of the demand continues to exceed the possible natural supply even under the improved transportation conditions provided by steeper gradients. The point is now reached where it may be possible and is desirable to do something about it.

The local area receives water from a local stream or streams which normally flow in flood stage through part of the winter or non-irrigating portion of the season. Much of this water usually sweeps out to sea and is lost. Any portion of this waste flood water that can be put underground to increase the normal infiltration will augment the pumping supply. Infiltration should be increased by expanding the area in contact with the supply or by extending the period of infiltration. Diversion of a clear water increment of the flood waters over the gravels of the prehistoric stream debris cones is one effective procedure to increase percolating areas. If the floods are trapped behind dams at higher elevations, they can be released as constant flow throughout the season increasing infiltration time, and if small gravel or earth banks are put across the stream beds in the areas where the gravel strata are crossed, additional percolating surface can be provided and for increased periods of time as well. Some of the regulated flow might be spread over the gravel benches provided in prehistoric stream deposits. (Continued on page 102)

This paper was prepared expressly for AGRICULTURAL ENGINEERING. C. N. JOHNSTON is associate irrigation engineer, University of California.

# The Value of Consulting Work for Teacher Development

By H. B. Walker

FELLOW A.S.A.E.

**T**HE engineering consultant must possess some superior knowledge before his services are sought on a paid basis. In a way all of us are consultants, and the measure of our recognized abilities in a particular field is the demand coming to each of us for consultation whether paid for or not. I presume the most tangible measure of our value as consultants is the rate of pay we may demand and obtain for our consulting services. Thus paid consulting service tends to place an appraisal on the value of personal service and in this way builds up the individual's self-confidence and inspires him to become more proficient along some special line or lines of endeavor. Likewise, it provides a constantly expanding background of professional consciousness and responsibility, which depends in turn upon an expanding experience based upon successful practice. This of course provides a splendid background for teaching engineering subjects, since it brings into focus the practical applications of engineering as a service to society. It has a definite broadening effect upon the individual both from the professional and the student viewpoints.

No man can command value as a consultant unless he possesses proficiency along some line of interest to those who would consult him. If he occupies such a distinguished position, he must of necessity be a student in his field and through a series of experiences must have demonstrated his particular abilities. No engineer becomes a consultant by mere declaration. True enough, there must be an initial experience, which provides the opportunity to prove proficiency, but it is a series of these experiences which attract clients and the frequency of these experiences with distinguished clients really establishes his worth as a consultant.

The nature of agricultural engineering education and its most fortunate position in being established exclusively in land-grant colleges and experiment stations do not afford numerous opportunities to build up a paid consulting practice, but this need not shut out opportunities for consulting experience. Many of the land-grant institutions do not permit their agricultural engineering employees to accept consulting fees within the respective states, but a limited practice may be permitted elsewhere. Personally I favor such an administrative policy particularly in institutions where the agricultural engineering staff is an official part of the experiment station staff, and this, I believe, should be so in all land-grant institutions.

## SERVICE CALLS FOR CONSULTING EXPERIENCE

The nature of our service to agriculture calls for consulting experience, for after all it is a form of mutual cooperation, and an agricultural engineer who can't cooperate must be a real genius in some highly technical field if he renders a complete individual service to agriculture. Thus the nature of our employment provides ample opportunity for development as consultants, and if we as teachers do not enjoy these opportunities, it probably connotes either an uncooperative personality or limited native intelligence or both. I cannot feel that we have many like that in the agricultural engineering profession.

What then should be our attitude toward the development

This paper was presented before the Agricultural Engineering Teaching Seminar sponsored by the American Society of Agricultural Engineers at Purdue University, Lafayette, Ind., August 30 to September 4, 1946.

H. B. WALKER is professor of agricultural engineering, and head of the division, University of California.

of consulting experience as an aid to teaching, and what are some of the problems to be met? Let us keep in mind two phases of the measure of success in consulting experience, both of which are the same, but the measure of professional attainments is different. These are (1) the technical standing of those with whom you consult and (2) the pay you may command as a consultant. Of these two, the former is more important in your development as a consultant and teacher, but the latter probably yields more direct personal satisfaction since it constitutes a tangible measure.

To become a consultant one must possess some attractant in the way of technical or professional abilities. People don't come to your doorstep for general knowledge. They want to know something in particular about something which is important to them, but the attainment of this knowledge is not readily available for their immediate purpose. Generally, people who consult others on technical matters are far above the average in intelligence, and they are likely to be severely critical of the knowledge they seek. For this reason they are stimulating. The more they have to pay for this knowledge, the more critical they are apt to be, because the moment one establishes a consulting rate he fixes in the mind of his client the potential value of his services. In such cases the paid consultant delivers with the "know how" or quickly sinks into oblivion as a consultant.

## CONSULTANTS NEED SUPERIOR KNOWLEDGE

The first requirement in the development of consulting experience is the recognition of the opportunity. Remember, administrative policies may restrict teacher opportunities for paid services, but these need not be deterrents in the development of consulting abilities. Likewise, you have no right to be consulted unless you possess superior knowledge. The larger the organization of which you are a part, the more favorable are your opportunities to develop into a valuable consultant. This is because there are greater opportunities for you to become a specialist, and more than likely you had to possess some specialized knowledge in order to qualify for initial employment. The most difficult situation exists for the one-man department teacher. His position requires such a dispersion of effort that specialized work becomes difficult. If he must devote all of his time to teaching, his opportunities for becoming a highly paid consultant are practically nil, and he may not be in great demand as an institutional consultant. If he is privileged to do research, and may I say I hope this is possible for every teacher, his opportunities are tremendously expanded. Research stimulates the will to know more about some particular thing. It stimulates library research, and all of us should be more conscious of the unused and little known treasures to be found in our storehouses of knowledge—the libraries.

When a teacher and/or research worker solves some difficult but important problem in a new and scientifically sound manner he has demonstrated a measure of competency in a particular field. He may know more and more about less and less, as the humorists refer to an expert, but he does know more than others about something, and he qualifies as a consultant in that particular matter. If he possesses that rather rare ability, to generalize his new knowledge into other fields, he is more likely to be sought as a consultant. He has demonstrated by tangible procedures his ability to think straight, and he has developed the knowledge essential to solve a particular group or class of problems. We should not deceive ourselves, however, that the mere ability to think straight quali-

fies a man to become a consultant. He must possess the essential knowledge that goes with straight thinking. A lack of knowledge always disqualifies a man no matter how logical his thinking may be. Moreover, the consultant who may have developed expertness in some particular field should be careful not to commit the common error of human beings that this qualifies him for expertness in every field. Knowledge—a little of it—may be dangerous, but knowledge is an essential element for a successful consulting development. If the consultant possesses superior knowledge, he has an opportunity to succeed when he uses this with straight thinking.

With such a background of experience his teaching in his special field becomes more logical in presentation, of greater interest to the student, and the learning of the student is accelerated because his application of principles have been tested by personal experience.

Experiment station workers are likely to be sought as consultants, particularly if they have basic knowledge of such scientific fields as fluid mechanics, electronics, dynamics of machines or soils, air turbulence, etc. These are essential background subjects for specialized engineering knowledge of a distinctive type.

#### BASIC SCIENTIFIC KNOWLEDGE ESSENTIAL

If your experiment station or teaching colleagues consult you about your chief technical interest, it is tangible evidence of recognition of your superior knowledge in some particular field. You should accept this as a high compliment to your ability, and it should inspire you to greater efforts and further study in the field of your specialty.

Informal consultations with industrial leaders are sure to occur if agricultural engineering staffs are actually doing worth-while work. These may be quite variable in character and represent the various fields of agricultural engineering activities of which there are many. Likewise, the industrial representatives may range from salesmen to chief engineers or other senior officers of companies. Oftentimes initial visits are merely courtesy calls, but they afford an opportunity to indicate the interests of the staff and to show or demonstrate work in progress. All of this may seem to be quite remote from engineering consultation, but it has been my experience that while such representatives may initially make calls through courtesy, eventually such calls are made more or less periodically to consult with particular staff members. It is a great satisfaction to an administrator to know the men on his staff command the respect of representatives in commercial fields where interests are mutual. Such consulting work, I hope, is mutually beneficial. I am sure it has great value to staff members, and judging from the visitor list at our own institution, it must have technical value to those who come, for the repeat visits from engineering departments of the larger corporations are increasingly numerous. What should be our attitude in encouraging these relationships? First of all, no one comes often to your doorstep unless there is technical interest and hospitality there. Thus you must have something to attract the visitor. It may be no more than a viewpoint, which the visitor finds inspiring or refreshing, or, better yet, it may be a project you are engaged in which has industrial significance. In any case there must be some mutuality of interest and frankness in exchange of viewpoints. While such calls may be rather indefinite at first, they may be expanded into mutually profitable experiences.

Secondly, if you are to develop consulting experience, you must be able to translate your interests and knowledge into the interests of the client. Seek his viewpoint of the problem, and endeavor to solve the problem from that angle. The client's satisfaction is all important to you so long as his demands can be met by sound engineering methods. Thus, if you would develop your consulting abilities, you will treat

each person who consults you the same as if he were a paying client. In this way you establish a reputation in your field through the satisfaction of the client.

These experiences do two things for the teacher. First, it trains him in logical analysis which stimulates him to expand his knowledge in the field of his specialty, and, secondly, he gains experience in viewing problems from the client's standpoint. These two things are of direct value to the teacher. Logical analysis is essential for good teaching and students after all are clients of the teacher. If the teacher can recognize the student's viewpoint, he is much better able to organize his subject matter for presentation. Thus the learning curve of the student will be steeper which is always a satisfaction to both teacher and student. This constitutes good teaching.

Bear in mind, your abilities as a consultant are measured to a considerable degree by the standing and reputation of the men who seek your assistance. A person gains in professional stature when he has an opportunity to associate with others who have superior knowledge and broader experiences. The chief engineer of any organization is a distinctive visitor. If he happens to be connected with an organization of national or international importance, his visit is even more distinctive. Every visitor should be extended the same courtesy and meticulous analysis of specific problems. The difference in visitors is more likely to be one of viewpoint of approach. Thus consulting work, while based essentially upon a superior knowledge of some technical field, is not a standardized service. It must take into account individualized problems, requiring personalized, objective solutions. The more successful one becomes in meeting these requirements, the more successful he becomes as a consultant. This attitude of approach calls for personal resourcefulness in the consultant, but it never requires a sacrifice in sound engineering analysis.

It is well for the would-be consultant to remember that the man who seeks your advice always has a problem that is important to him. If he is willing to pay for your advice, it affords an opportunity to appraise the importance of the problem to him. In our experiment stations there is a lot of informal consulting work for which there are no provisions for compensation. This is as it should be. This may lead to some abuse of service, and it may tend to cultivate an indifference upon the part of the teacher toward such mutual help. I hope we as agricultural engineers will never become indifferent in such matters. If your colleague comes to you for assistance, he undoubtedly has something to discuss which is important to him. If you are qualified to assist him, he should be treated much the same as a paying client. If you can't help him, he should know the reason why, but in any case he has honored you with an opportunity for service.

#### CONSULTANT MUST ESTABLISH REPUTATION

Before one can become a paid consultant, he must have established a reputation for outstanding proficiency along some line. If you are indifferent to your colleagues they can do little to aid you in establishing a reputation. If you have served them well they will refer others to you, some of whom may become paying clients. Thus your future as a consultant is not determined by desire, or choice, but by performance. It depends upon what others think of your abilities. The impression you leave with clients will determine your reputation. Every person who consults with you, whether a paying client, colleague, or interested man from industry contributes to this reputation. The treatment they receive when they honor you through consultation will have more to do in establishing this reputation than any other single factor. This is based directly on an appraisal of your abilities, your courtesy and tact in dealing with clients, your capacity to analyze problems and grasp the viewpoint of the client, and your ability to recognize

the controls and bottlenecks in technical analysis and thus reach logical solutions without loss of time.

If you should become a paid consultant, what constitutes appropriate fees? Generally speaking, when a client seeks advice, he has a particular problem and he seeks a prompt answer. He comes to you because he believes you can give him the correct answer with the least loss of time. This is the type of consulting experience most likely to come to the teacher. It is a form of short-term employment usually handled on a per diem basis. The service charge should be in keeping with the value of the service to the client. In no case, if it has a charge value at all, should it be a charge similar to a fixed salary income. It should be *much more*. The client seeks an answer valuable to him; he wants it quickly; he comes to you because of your background of training and experience which may involve years of study and experience upon your part; he pays you a fee, which you are permitted to fix as a measure of your personal evaluation. If it is low, he will expect mediocre service. If it is in keeping with the full responsibilities involved, it will be respected, you will be obliged to extend your abilities to top professional level, and your likelihood of rendering a competent consultant service will be enhanced. Be sure to charge enough.

#### BASIS OF CONSULTANT COMPENSATION

The teacher consultant, if he is really worthy of being called such, should receive a per diem compensation of not less than five times his equivalent normal per diem pay, up to \$100 per day. Of course all expenses should be in addition thereto. Generally a per diem should be based upon a 365-day year and charges made for each and every calendar day, from the time of beginning employment to the date of return to regular duties. Where the nature of the services merit higher charges than \$100 per diem and expenses, each consultant should be capable of estimating his worth to the client. Court cases, or other work involving expert testimony, should command higher rates of compensation, oftentimes double the normal consulting fee.

Where consultation may be anticipated in advance on an intermittent basis to a company or individual demanding exclusive service, then a retainer contract is desirable. It would seem to me that this form of consulting work is the least desirable for a person employed in a land-grant institution, for it constitutes a certain monopoly of service.

Federal and state agencies often desire special services from employees of land-grant institutions. This may be a special problem, or short-time contract work, of a consulting nature which may be handled quite properly on a different basis of compensation. In such cases compensation may be nearer the base rate of pay of the individual, but it should never be less and preferably up to 50 per cent more. Regulations of such agencies usually fix the method and rate of compensation, and the acceptance or rejection of contracts depends upon individual judgment. In any case, these experiences are comparable to consulting practice and teachers should be encouraged to take advantage of them when practicable. However, the teacher must expect to work much harder on these special assignments than if engaged in his regular institutional activities. Consulting work of any nature requires this.

In summarizing my thoughts on the value of consulting work for teacher improvement, I should like to call attention to the following:

1 To become a consultant one must possess exceptional specialized knowledge and abilities.

2 Any teacher who can qualify as a consultant is a better teacher.

3 Consulting abilities can be developed through institutional experiences.

4 The point of view of the client is of paramount importance in successful consulting practice.

5 The teacher should treat every visitor who comes to consult him regarding technical matters as an actual or a potential client.

6 A measure of your ability as a consultant may be judged by the technical standing of those who come to consult with you.

7 If your services as a consultant are valuable, be sure your fees are in keeping with the services required. Do not undercharge.

8 If you are a consultant, remember any matter a client brings to you must be assumed to have importance to him and therefore requires your careful and meticulous attention.

9 In consulting practice, your clients are generally people of superior abilities seeking special knowledge. They have a right to be critical of your findings.

10 The relationships between a consultant and his client are not unlike those of a teacher with his students. Students are clients. If your clients succeed, you are a successful consultant, or, likewise, a successful teacher.

11 If you are a member of the experiment station staff, cultivate the consulting method with your colleagues. You are sure to profit.

12 Exchange experiences with state and federal agencies on special assignments suited to your abilities are comparable in value to teachers as paid consulting work.

### Ground Water in California

(Continued from page 99)

All these measures supplement the natural supply, and raised water levels in former overdraught areas prove the effectiveness of the measures. In fact, it is one of the objects of the Central Valley Project of the U. S. Bureau of Reclamation to supply water for underground storage using the methods outlined above.

The large valley trough is a grand scale replica of each minor drainage system in the state, so the measures are adaptable to about all underground pumping areas. The only limiting feature to the application of such measures is the lack of adequate water supplies in some localities.

The preceding discussion can be construed as focussed upon the irrigation wells. Stock and small domestic wells fall often in another category, being small in size, relatively shallow in over-all depth, and of limited capacity. Such wells often tap strata not directly affected by percolation from areas near the top of the alluvial fan and are connected to the streams by later deposits in contact locally with surface flow. In such cases the water levels in the shallow wells behave differently from those in the deep wells in that area making the recording of water level data somewhat more complicated than it would be were only one locality of supply involved for both types of wells.

Near the center of valleys the alluvial fill is one to several thousand feet deep, and near the head of the fans often less than one hundred feet deep. As a result, wells vary in depth from less than a hundred feet to over a thousand feet and in size from 3 in to as much as 20 in in diameter. Costs and capacities are as widely divergent, so no tabulation figures are possible. However, in many areas irrigation wells producing 40 gal or more per foot of drawdown are considered good. Many produce over 100 gal per foot of drawdown. These figures are not reached in other areas where supplies are limited or the conducting strata are tight.

# Quality Hay Defined

By C. B. Bender

**W**HY is there so much interest in quality hay? We have gotten along in the livestock industry for years on any kind of hay. Yes, we had good hay and poor hay, abundant hay crops and short hay crops over the years. Supplementing these hays with silage and plenty of grain and protein seemed to take care of the production of milk, meat, and wool pretty well. Many livestock men had the idea that cheap grain feeds and protein supplements were the answer to low-cost production.

It is true that research workers have been investigating the hay plant for years. They have shown that the chemical composition of hay depends on the botanical composition of the herbage in the field, the stage of maturity when the plants are cut, the soil type and fertility level of the field, climatic conditions, and the manner in which the crop was made into hay.

As early as the late 1800's it was found that 20 per cent of the dry matter in hay could be lost by soaking it in cold water. Clover and alfalfa can lose from 25 to 50 per cent of its dry matter by rain. These losses are due to leaching, bleaching, shattering of leaves and stems, followed by changes in composition due to the action of moisture, enzymes, and heat. The losses of nutrients for the most part were the soluble, most easily digestible ones.

Over the years the research worker found patterns of symptoms in the herds and flocks that were definitely tied up with the quality of the roughage. This poor quality hay is often the cause of vitamin and mineral deficiencies manifested by calves, colts, and lambs suffering from pneumonia, night blindness, rickets, digestive disturbances, general unthriftiness, and death. In the older animals poor quality roughage may cause lack of thrift and a poor breeding history.

Poor hay contributed to our national shortage of protein. Excellent alfalfa hay may contain 18 per cent of protein; poor alfalfa will contain 10 per cent. Excellent timothy cut at the right stage of maturity will contain 10 to 11 per cent protein and poor timothy will contain 5 per cent. However, this is only part of the protein picture. The proteins in the excellent hays have a higher coefficient of digestibility when put through the animal's digestive tract.

Let's look at this protein picture in another way. Alfalfa on fertile soils will yield four tons of hay per acre. Cured into excellent hay, the protein yield will be 1440 lb per acre. The poor hay will yield 800 lb of protein per acre. This is a difference of 640 lb of protein without calculating the increase in digestible protein of the excellent quality hay. It would take the protein of 28 bu of soybeans or 118 bu of corn to make up this difference.

We in the research and extension fields have preached high-quality roughage to livestock men for years. Yes, we have had some converts, but the rank and file of livestock men was unimpressed. It took World War II with its shortages of both protein supplements and energy feeds to create a profound interest in the conservation of the nutrients in hay as a means of "getting by". During this period many dairymen found that good quality roughages not only kept up milk production in their herds when they fed home-grown energy feeds such as mixtures of corn, oats, barley, and wheat, but they were also able to produce the milk on less grain. Those of us in the research field knew this was possible, but it took a

national calamity to drive the picture home. Furthermore, the livestock men found that production costs were reduced when greater reliance was placed on high-quality roughage produced on the farm under their control.

Thus far only the protein picture has been stressed. Now let's look at the total digestible nutrient or energy values of excellent hay. This picture is comparatively the same as the protein picture. Excellent quality hay will have 53.7 lb of total digestible nutrients in every 100 lb while poor hay will have 44.9 lb, or a difference of 176 lb per ton. In a four-ton-per-acre yield of alfalfa that would amount to 704 lb of nutrients. This is equivalent to 15.5 bu of corn.

The greatest roughage burners are the ruminants. The cow is the leading member of this group. It was designed by nature to consume liberal quantities of roughage. With its four stomachs and intestinal tract it has a capacity of eight 40-qt milk cans. Too many of our dairymen have tried to convert this animal to a grain burner because it is easier to feed grain. These same dairy or livestock men close their eyes to the fact that the protein and nutrients in grain are the most expensive ones fed to livestock.

In order to have high-quality hay we must of necessity start with the soil on which it is produced, because there are many studies which show that the plant reflects the nutrition of the soil.

As a rule roughages are good sources of calcium; however, on acid soils or soils of low available calcium content lower calcium values are found in the plants.

Phosphorus deficiencies in cattle have been reported in many areas. These deficiencies become manifest and have been described as pica, stiffness, osteophagia, anorexia, and decreased feed utilization has been observed. Frequently these deficiency diseases have been traced to the roughages. Greater utilization of roughage by the animal tends to accentuate this trouble. Fertilizing the soil with phosphorus or feeding steamed bone meal overcomes the deficiency symptoms.

Iodine, manganese, iron, copper, cobalt, and magnesium in adequate amounts in the soil, or in the soil complex in short supply, all have their role to play in the nutrition of the plant and the animal.

Soil fertility was found to have a definite effect on the carotene and protein content of plants. A lack of nitrate nitrogen adversely affected the carotene and chlorophyll content. Nitrate nitrogen seems to be superior to ammonium nitrogen from this standpoint.

There is a relation between rainfall and the chemical composition of the plant. When alfalfa is grown under conditions of sufficient rainfall, it is higher in phosphorus and lower in calcium than when grown in arid regions. The amount and seasonal distribution of rainfall are factors influencing the dry matter and protein yield of the plant. Phosphorus deficiency outbreaks are usually observed following a drought. In areas of limited rainfall herbage is generally low in protein.

When discussing the vitamin content of roughages, carotene or pro-vitamin A is usually thought of first. As has been previously mentioned, it is affected by nitrogen fertilization. There also is a variation in its synthesis due to the species of plant as well as the stage of maturity of the plant. It is higher in the rapidly growing plant and usually reaches its maximum before or at early bloom stage. In pasture the highest carotene concentration is in the spring and again in the fall after the fall rains.

The vitamin D picture is somewhat different. Green forage, grass silage, artificially dried hays are almost completely

This paper was presented at the Third Barn Hay-Curing Conference sponsored by the American Society of Agricultural Engineers at Chicago, Ill., December, 1946.

C. B. BENDER is research specialist in dairy husbandry, New Jersey Agricultural Experiment Station.

lacking in it. Sun-cured hay has usually an ample supply to protect calves against rickets.

Vitamin E seems to be in good supply in sun-cured hay. Artificially dried hay retains a higher potency of this vitamin.

The vitamin C content of roughage is thought to be good in the green plant. Deficiency symptoms usually do not occur in cattle because of their ability to synthesize it. The same thing holds true for the B complex.

In addition to the factors previously listed, the stage of maturity of the plant plays a major role in the chemical composition of the plant at the time of harvest:

- 1 Crude protein decreases with growth but remains constant after bloom.
- 2 The dry matter increases until seeds are formed.
- 3 Crude fiber increases steadily until seed formation then tends to decrease slightly.
- 4 Ether extract generally decreases until blossoming at which time it increases until seed begins to form. A decrease then follows, the low point being at the time the seed begins to harden.
- 5 Nitrogen-free extract increases with approaching maturity.
- 6 Ash decreases with approaching maturity.
- 7 The digestible matter is greatest at the prebloom stage.
- 8 Sugars decrease with increasing age of plant.
- 9 The pentosans, cellulose, and lignin increase with age.
- 10 Pectin and fructosan decrease as plants grow older.
- 11 Carotene, ascorbic acid, vitamins B<sub>1</sub> and B<sub>2</sub> decrease as the plants mature.

#### NUTRIENT LOSSES MUST BE REDUCED

It can be said axiomatically that we can grow excellent hay crops but that we fail miserably in curing them as hay. The losses in protein nutrients and minerals in the normal haying processes are too high. The greatest losses are due to leaching, bleaching, heating and overhandling. These losses are too well known to spend any time on them, except to state that they run from 20 to 50 per cent of the nutrient content of the plant. This increases production costs and affects the health and well being of our livestock. These losses must be reduced by improvements in hay-making operations.

Yes, artificial dehydration conserves more of the nutrients than any other method, but it is too expensive. We must perfect other means of curing that will give us just as good hay at greatly reduced curing costs. Brown or black hay is out because of the tremendous nutrient losses. Flue or mow curing of hay points a way out but more work must be conducted in order to perfect the system. Hay crushing may be an aid in the system or other methods may be discovered. One fact is clear; these losses must be reduced.

Now in the light of this discussion, what is the definition of quality hay? The best definition I can formulate is the following:

Quality hay is any legume or grass of economic value to livestock, grown on well-limed, fertile soils, cut in the early bloom stage, and cured rapidly with a minimum loss of nutrients and minerals. This hay is green in color, the leaves are intact upon the stems, has a pleasant aroma, and is free from dust.

Hay with its teammates, grass silage or corn silage, form the roughage combination upon which the cattle industry of our country is based. In addition, hay plays a major role in the diet of horses and sheep and a minor but important role in the diet of swine and poultry.

The economic production of winter milk is based on the feeding of quality hay in liberal amounts. An increase in the hay consumed by milking cows means a reduction in the grain requirements for maximum production. The difference

between the nutrient effect of poor quality hay and hay of excellent quality on milk production may best be expressed in the following terms: For every ton of hay of poor quality a cow is forced to eat, 500 lb of additional grain must be fed to maintain production. The nutrients furnished by quality hay can be produced more cheaply than grain nutrients; therefore, the soundest feeding economy is based on liberal feeding of the cheapest nutrients.

The greatest enemies of quality hay production are low soil fertility, the cutting of plants for hay when they are too mature, overcuring in the swath and windrow which causes bleaching, leaching losses due to rain, and the shattering of leaves due to overhandling. Nutrient losses from any one or a combination of these causes may total from 20 to 50 per cent.

A ton of excellent quality hay will contain better than 1000 lb of total digestible nutrients. Well-fertilized hay lands will easily produce four tons of hay per acre. If a farm has 40 acres of its area in alfalfa and the average loss of nutrients is 30 per cent, that means a feeding value loss equivalent to 48 tons of hay or 32 tons of dairy feed. At the price of dairy feed on today's market, that would be \$2,560.

Our goal today is to develop means to reduce these losses, and dairy farmers will use the methods developed, if by following them they can be assured a good return on their investment.

The plant reflects the nutrition of the soil; the animal the nutrition of the plant. The human family in nutritional health is dependent to a large extent upon these same animals, through milk, butter, eggs, and meat. It is our challenge to devise means to protect this nutritional chain.

## Missouri Valley Development

IN ANY basin-wide development, conflicting interests are bound to arise. Such comprehensive programs of necessity affect many interests and the welfare and desires of many people. Experience shows that we cannot give to each interest everything it wants. There always must be compromises, a give and take.

The Army Engineers look to local, state, and regional organizations to reconcile differences that may exist, to recommend adjustments that are reasonable and fair to all concerned, and to promote cooperative support.

We have several excellent examples of cooperation at many levels—federal, state, and local. In the Missouri River two plans were integrated into a comprehensive program—a basin-wide plan prepared by the Corps of Engineers with flood control and navigation as the primary purposes, but with corollary benefits through other water uses; and a program of the Bureau of Reclamation designed primarily for irrigation and reclamation. Here unity of support led by a committee of the ten states' governors resulted in authorization of the over-all program. Appropriations made by Congress for 1946 and 1947 have made possible the inauguration of work in the Missouri basin last summer on five multiple-purpose dams in five states, additional flood protection works in several areas, and the inauguration of several Bureau of Reclamation projects. Free expression of opinion is offered and fostered by a Missouri basin interagency committee, which meets once a month and consists of field representatives of the Corps of Engineers, the Department of the Interior, the Department of Agriculture, the Federal Power Commission, and four governors appointed to represent the ten states.

Under a provision contained in the 1944 Flood Control Act, the Corps of Engineers is authorized to construct, maintain, and operate public park and recreational facilities in areas under engineer control. In formulating the program of development and management for recreational uses, we are obtaining the views of federal, state, and local governmental agencies, and of other interested groups and individuals. To insure an orderly development of all such potentialities in our various areas, we are preparing master recreational plans for the more important projects.—Lt. Gen. Raymond A. Wheeler in the "Journal of the Western Society of Engineers" for December, 1946.

# Mow-Drying Chopped and Long Alfalfa Hay

By Roy B. Davis, Jr.  
JUNIOR MEMBER A.S.A.E.

**T**HIS is a progress report of one phase of hay-drying investigations conducted during 1946 at the Virginia Agricultural Experiment Station in cooperation with the Farm Electrification Division, U. S. Department of Agriculture, which included several problems of considerable interest in Virginia and in many of the other states where hay is being mow dried. A comparison of the factors involved in drying chopped and long alfalfa hay was one of the major considerations. This is a broad problem and although several observations were made much remains to be done.

**Experimental Equipment and Procedure\*.** Two drying bins were provided in order that comparative tests might be made. Each of these bins (Fig. 1) had a floor of 8x8 ft and a depth of 12 ft. The corners of the bins were rounded on a two-foot radius and the inside walls were smooth and airtight. The floor was made of 3-in slats placed 6 in on center and supported by joists. The outer portion of the floor was covered so that only one-fourth of the total floor area was open for the air to enter the hay. Each bin was mounted on recording scales in order that a continuous record of the weight of the hay could be obtained. A plenum chamber was provided underneath each bin to reduce the effect of the velocity, or impact, pressure of the air before it entered the hay. To further reduce the effect of the velocity pressure a tapered expansion joint was used to connect the plenum chamber to the air supply duct. This joint contained an air splitter which was designed to reduce the turbulence of the air.

The air supply duct was constructed to facilitate reliable air flow measurements and contained a thin-plate orifice and honeycomb straighteners. The thin-plate orifice and an inclined differential pressure manometer was used to measure the flow of air. Each orifice was calibrated in place by both a velometer and anemometer traverse. The average of the two measurements was used to give the calibration curve for the orifice in use. The difference in the air flow, as measured by the two instruments, was relatively small. The air was supplied by a centrifugal blower driven by an electric motor through a variable-speed, V-belt drive. This drive allowed the speed of the fan to be varied to give the desired flow of air.

If desired, the air entering the blower could be preheated by a stoker-fired furnace. In this case the air was drawn into a large duct, around the pipes of a heat transfer unit,

This paper was presented at the Third Barn Hay-Curing Conference sponsored by the American Society of Agricultural Engineers at Chicago, Ill., December, 1946.

ROY B. DAVIS, JR., is assistant agricultural engineer, Virginia Agricultural Experiment Station, and collaborator, Farm Electrification Division (BPISAE), U. S. Department of Agriculture.

\*The author desires to give credit to A. T. Hendrix, formerly agricultural engineer, U. S. Department of Agriculture, for his contribution to this investigation prior to his resignation in June, 1946.

over the warm-air furnace and to either or both of the blowers. The temperature of the air was thermostatically controlled at about 90°F. The preheated air could be cut off by means of doors and air under existing atmospheric conditions could be taken in by either or both blowers.

For the tests comparing chopped and long hay, each bin was initially filled with 4350 lb of alfalfa hay. The hay was brought from the field and divided at the bins. Half was chopped with a stationary chopper and pitched manually into one of the bins. The other half was placed manually in the second bin without having been chopped. Hay was spread as uniformly as possible and tramped around the sides and in the rounded corners of the bins to prevent excessive air flow at those points. The average length of cut of the chopped hay was 2½ in. The bin containing the long hay was filled to a depth of 8 ft 3 in and the chopped hay to a depth of 8 ft 4 in. The moisture content of the long hay was 50 per cent and of the chopped hay 49 per cent, as determined by sampling and drying the samples in an electric oven.

The intermediate points shown in Fig. 2 show the depth at which the weight of hay in each bin was equal on filling. As the long hay was placed in the bin, a net was spread across the hay at two-foot intervals of depth. The long hay was weighed and enough chopped hay was placed in the other bin to equal this weight. Then a corresponding net was spread across the chopped hay bin, allowing observations to be made on the amount of settling, quality, and other factors within each layer. During drying this initial filling settled to a depth of 5 ft 9 in in the chopped hay bin and 6 ft in the long hay bin.

Without removing this dry hay, 1806 lb of hay with a moisture content of 46 per cent was placed in each bin in the manner previously described. This increased the depth of the long hay to 10 ft and of the chopped hay to 9 ft 6 in. When this hay was dried, the long hay was 8 ft 8 in deep and the chopped hay 8 ft 3 in. When the hay was removed, the nets in the column of hay were at the points indicated in the "re-

moval" column shown in Fig. 2. It was observed that the subsequent filling had compressed the initial filling of hay 4 in, also that less than 0.5 per cent of the weight removed from the bins during the drying of the second filling was removed from the initial filling. An important observation, at least for these tests, was that the density of the chopped and the long hay in the bins was nearly equal.

**Rate of Drying.** With the bins filled as outlined above, the rate of drying of the initial and subsequent filling is shown in Fig. 3. To reduce the initial filling of chopped hay to 20 per cent moisture meant removing 1623 lb of water and required 104 hr of drying with an air flow of 15 cfm per sq ft of floor area. This gave a rate of water removal of 15.6 lb per hr. Supplemental heat was used in both tests. Water was removed from the subse-

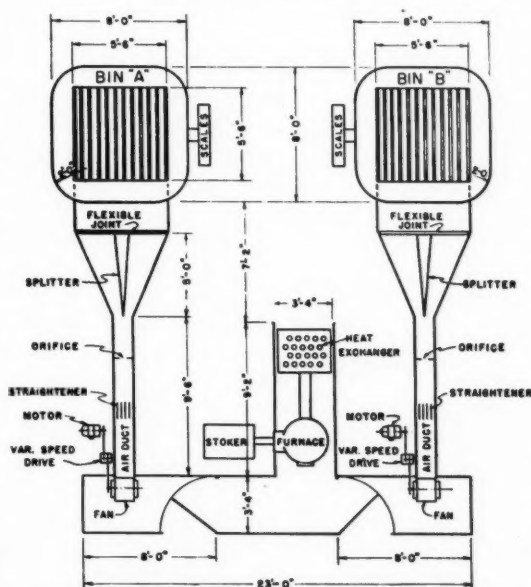


Fig. 1 A plan view of the experimental mow-drying installation

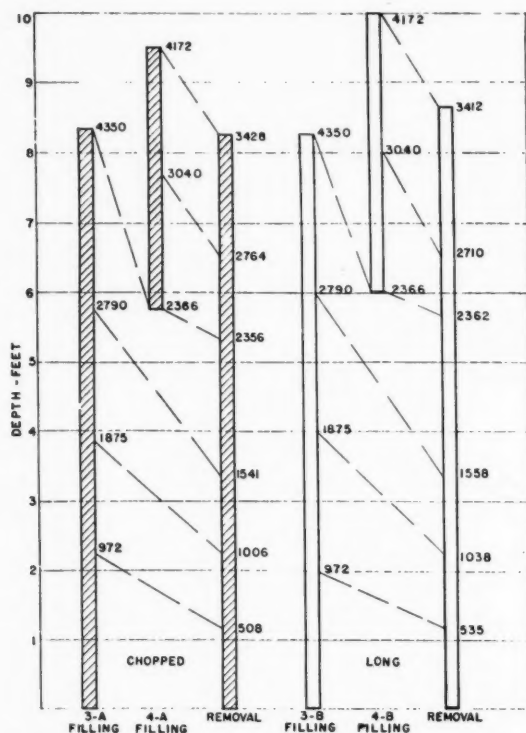


Fig. 2 The intermediate points shown on this chart indicate the depth at which the weight of hay in each bin was equal on filling

quent filling of chopped hay at the rate of 8.3 lb per hr. The long hay dried at the rate of 16.4 lb per hr for the initial filling and 10.5 lb per hr for the subsequent filling. At first glance it appears that the chopped hay was slower to dry than the long hay, but when the temperature and humidity of the entering air is considered, it is noted that the temperature was lower and the humidity higher in the case of the chopped hay. This makes this comparison questionable. The difference in the temperature and humidity of the air entering the chopped hay from that of the long hay was caused by a slightly longer air duct from the furnace to the hay and by its location in

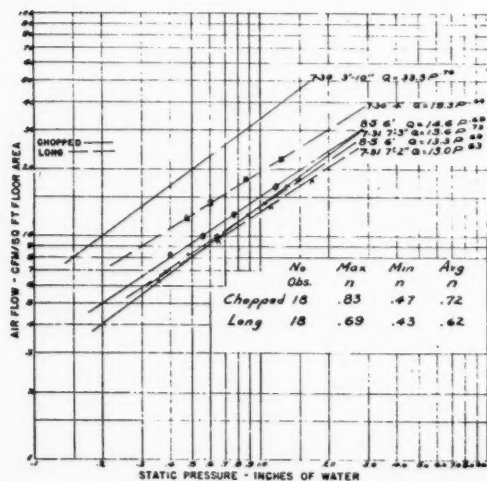


Fig. 4 This graph shows the relation of air flow to static pressure

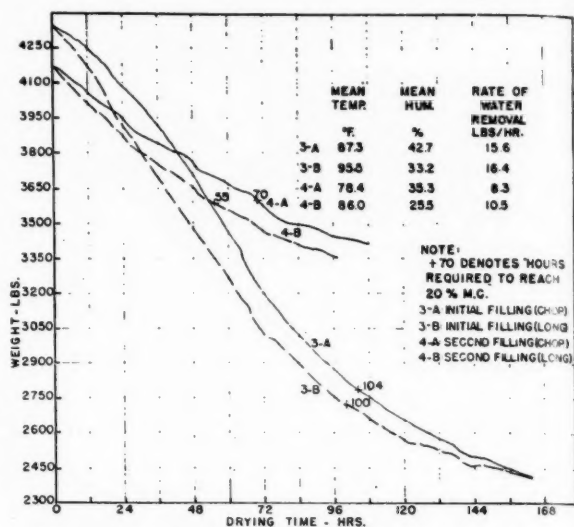


Fig. 3 This graph shows the rate of drying of the initial and subsequent filling

the shadow of the roof of the installation. The duct leading to the long hay was shorter and was near enough the edge of the shed to absorb the heat from the sun during the day. This reduced the amount of heat loss from the latter duct.

In both cases the hourly drying rate was lower for the subsequent filling than for the initial filling. It must be recognized that the depth of the green hay in the later filling was less, the initial moisture content lower, and the air leaving the hay less saturated by some 10 per cent. In other words, the moist hay was not sufficiently deep and did not contain enough water initially for the air passing through it to become saturated during the time the air was in contact with the hay.

**Air Flow Through the Hay.** The observations of air flow-static pressure relationship were found to follow the results reported by A. T. Hendrix last year in his paper, entitled "Observations on the Resistance of Air Flow" (AGRICULTURAL ENGINEERING, vol. 27, no. 5, pp. 209-212, May, 1946). That is, when plotted on logarithmic graph paper, the points conform very closely to a straight line as shown in Fig. 4. The relationship may be expressed by the equation  $Q = K P^n$ , where  $Q$  is air flow in cubic feet per minute per square foot

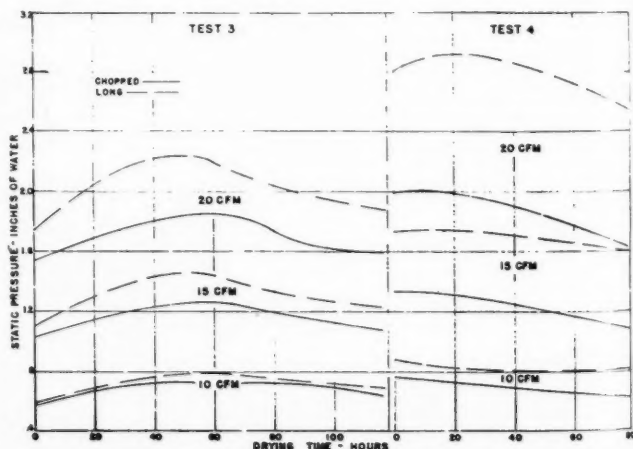


Fig. 5 Variations in the air flow-static pressure relationship plotted against drying time

of floor area,  $P$  is the static pressure in inches of water, and  $K$  and  $n$  are constants for the given conditions of the test. In comparing the different tests under consideration it was noted that the value of the exponent  $n$  was higher for chopped than for long hay. An average of 18 observations of the relationship in chopped hay gave an exponent of .72 while comparable observations in the long hay bin gave an exponent of .62. This indicates that an increase in static pressure will give a larger increase in air flow through chopped hay than through long hay of equal density.

When the variations of this relationship were plotted against the drying time, shown in Fig. 5, several interesting observations may be made. First, the static pressure required to produce a given air flow usually increased as the hay settled until considerable drying had been done and then decreased as the drying continued. Second, that for approximately the same density of chopped and long hay the static pressure required to produce a given air flow was less for the chopped hay and this difference in favor of the chopped hay increased as the rate of air flow increased.

The procedure used to reduce, as far as possible, the effect of the air losses along the sidewalls of the bins was essentially the same as that used by Mr. Hendrix in his studies in 1945, reported in his paper already referred to. The area of the bin was divided into two equal parts. One part was a strip around the walls of sufficient width to contain half of the area, and the other was the remaining center portion of the bin. The mean of the corrected values of the anemometer readings taken in each of these areas was used to determine the proportionate part of the air passing out of the hay in each of the areas. Using the portion of the total air that passed through the center area of the hay, the air flow per square foot of this area was computed. The resulting air flow per square foot of the center area was used in determining the various relationships relating to the air flow. This procedure showed no difference in the side leakage between the chopped and long hay.

**Effect of Depth on Pressure Drop.** When the observations of the static pressure—depth relationship made by probing were plotted on logarithmic graph paper they formed straight lines with few exceptions, as shown in Fig. 6. This indicates that the static pressure varies as some constant multiplied by the depth of the hay to some power. This power appears to

be affected a great deal by the compactness of the hay. The several conditions of compactness produced noticeable differences in the value of this exponent in both the chopped and long hay. The table in Fig. 6 gives the summary of the observations of this relationship. When the chopped hay was compacted to 271 cu ft of 20 per cent moisture hay per ton, the exponent was 1.83; an increase of 30 cu ft in the volume of 20 per cent hay per ton decreased the exponent value to 1.39. The variation in the value of the exponent in the long hay was similarly influenced. At present insufficient data prevent the establishment of the relationship between compactness and the value of the depth exponent. Usually, though not always, this exponent was of greatest value during the early stages of drying, decreasing to its minimum when the hay was dry.

The effect of the compactness on the static pressure required for a given air flow at the various depths is more clearly seen when the full equation of the pressure-depth relationship is plotted as in Fig. 7. Each curve represents the average value of the relationship as determined by at least three different observations at various times during the drying period. From Fig. 7 it is noted that 1 in static pressure will produce a flow of 15 cfm per sq ft of floor area through  $5\frac{1}{2}$  ft of chopped hay compacted to 271 cu ft per ton of 20 per cent hay, through  $5\frac{1}{2}$  ft of long hay of 277 cu ft per ton, and through  $8\frac{1}{2}$  ft of chopped hay at 301 cu ft per ton, while  $\frac{1}{2}$  in static pressure produces the same flow of air through  $6\frac{1}{2}$  ft of long hay at 312 cu ft per ton and through almost 11 ft of long hay at 351 cu ft per ton.

While sufficient data are not available to establish a fixed relationship between the degree of compactness and static pressure for a given depth or depth of hay for a given static

TABLE 1. OPERATING COSTS OF DRYING  
(Per ton of hay of 20 per cent moisture)

Test	Initial moisture, per cent	Drying time, hr	Electricity cost per ton	Heat cost per ton	Operating cost per ton
3 - A (Chopped)	49	104	\$ .41	\$ .60	\$1.01
3 - B (Long)	50	100	.47	.84	1.31
4 - A (Chopped)	46	70	.58	1.07	1.65
4 - B (Long)	46	55	.56	1.12	1.68

Note: Electricity, 2c per kw-hr; coal, \$8.00 per ton.

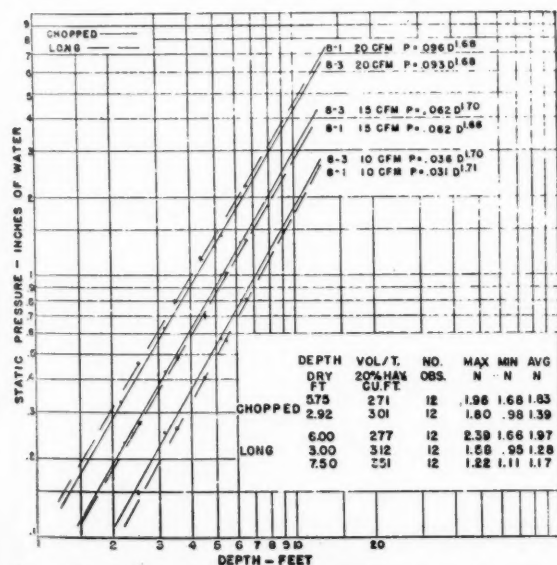


Fig. 6 Observations of the static pressure-depth relationship plotted on logarithmic paper

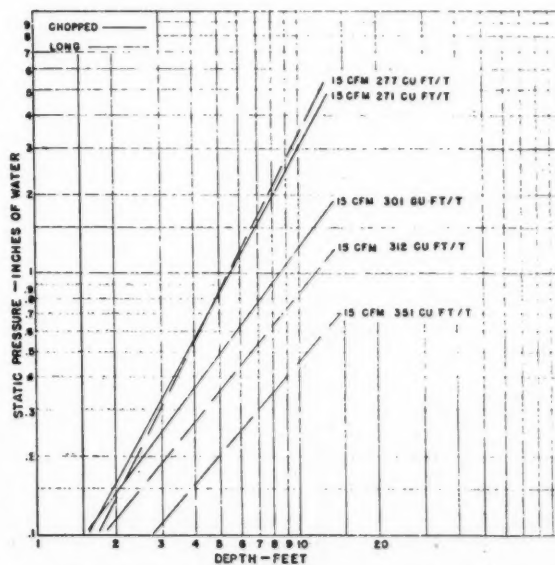


Fig. 7 This graph shows the effect of compactness on the static pressure required for a given air flow at various depths

**Observations on Cost of Drying.** To the hay producer one of the primary elements in the comparison is the cost of operation. This comparison for the tests under consideration is shown in Table 1. These costs were determined on the basis of the cost of electricity at 2c per kw-hr and coal at \$8 per ton. Using this information, these costs may be adjusted to the various sections of the country by using the prevailing rates of electricity and coal in each section. When studying the figures, care must be used to recall the drying conditions under which these tests were made. In test 4 the green material was dried on top of the dry hay from test 3. This required the fan to operate against a higher average static pressure and increased the cost of the electricity per ton of hay dried from 41 to 58c for the chopped hay and from 47 to 56c for the long hay. A lower outside air temperature during the drying period of test 4 increased the cost of the heat for this test. These costs are also affected by the reduced rate of water removal due to the lesser depth and the lower initial moisture content of the hay in test 4. Within each test there are also differences to be considered. In both tests the amount of heat supplied to the chopped hay was less than that supplied to the long hay which reduced the drying times for the long hay. This reduction in drying time was sufficient to make both the electricity cost and the heat costs in test 4 about equal. In test 3, however, this reduction was not as great and both costs favored the chopped hay.

**Comparison of Quality.** A glance at the "yardstick" of the quality of the hay produced will bring to a close this comparison of chopped and long hay. Table 2 shows the grades of the samples of hay, taken from comparable layers in both the chopped and long hay bins. The grades were determined by

TABLE 2. COMPARISON OF QUALITY

Test	Depth as filled, ft	Grade		Per cent leafiness		Per cent green color	
		C	L	C	L	C	L
4	2-4	USNo. 1 extra green alfalfa	USNo. 1 extra green alfalfa	45	45	80	90
		USNo. 1 extra green alfalfa	USNo. 1 extra green alfalfa	45	48	80	95
	0-2	USNo. 1 alfalfa	USNo. 1 alfalfa	45	40	65	70
		USNo. 1 extra green alfalfa	USNo. 1 extra green alfalfa	45	40	70	75
3	4-6	USNo. 1 extra green alfalfa	USNo. 1 extra green alfalfa	40	40	75	85
		USNo. 1 extra leafy alfalfa	USNo. 1 extra green alfalfa	45	40	80	80
	2-4	USNo. 1 extra green alfalfa	USNo. 1 extra green alfalfa	45	40	80	85
		USNo. 1 extra green alfalfa	USNo. 1 extra green alfalfa	45	40	80	85

the grain branch of the USDA Production and Marketing Administration. Table 2 is so arranged to show the vertical relationship of the samples as they were dried in the bin. Only twice is there a difference in the grade placed on samples from comparable layers. In test 3 the chopped hay in the layer extending from 2 to 4 ft from the bottom of the bin was graded "extra leafy", while the comparable sample of long hay was graded "extra green", and the 6 to 8 ft layer of long hay was graded "extra green", while its mate in the chopped hay failed to meet this requirement.

Several differences are noted when the per cent leafiness of the alfalfa and the per cent green color are considered. In six of the seven samples the chopped hay was graded to be as leafy or leafier than the long hay. It is felt that the cause of this increase in leafiness is not the method of preparation for drying but the loss of leaves from the long hay samples after they were dry. The leaves lost when the plants were separated from the mat in which they dried could easily have been

the cause for the lower percentage of leafiness. It is also noted that the percentage of green color favors the long hay by several points although in only one case is the difference sufficient to alter the grade. There appears to be at least two logical reasons for this higher green color in the long hay. The first is the slightly shorter drying time for the long hay which would preserve more the green color, and the second is that the bruising of the plant by chopping may crush some of the cellular structure to the extent that enzymatic action can more readily destroy the chlorophyll. Either of these reasons or a combination of the two may be sufficient to account for the loss.

## SUMMARY

In summarizing it is well to note that the results reported in this comparison cannot be deemed conclusions, but are merely limited observations. Further investigations may substantiate or modify them. Some of the major points of the comparison, however, are as follows:

1 The resistance of chopped and long hay to the flow of air as expressed in terms of the quantity of air forced through a given depth by varying static pressure may be expressed by the equation  $Q = KP^n$ ; the value of  $n$  is slightly higher for chopped hay than for long hay.

2 The static pressure required to produce a given air flow through chopped hay is slightly less than that required to force the same quantity of air through long hay of the same density.

3 The compactness, or density, of both chopped and long hay influences the static pressure-depth relationship to a marked degree.

4 The static pressure-depth relationship follows the same form as the air flow-static pressure relationship in both long and chopped hay, and the value of the exponent approaches unity as the density of the hay decreases.

5 The operating costs of drying favor the chopped hay by an exceedingly slight margin. A variation in the rates of coal or electricity from those used in this comparison may easily change this margin.

6 A comparison of the quality of the finished product reveals little difference between the chopped and the long hay. Even the slight advantage held by the long hay may easily be caused by the difference in the temperature and humidity of the air entering the bins.

## Heat in Barn Hay Curing

(Continued from page 97)

The damage occurring during this period will usually more than offset the extra cost of drying the hay from a high initial moisture content.

The cost of installing gas heating equipment on the average farm hay-curing system with a single-inlet fan is approximately \$100, including \$50 for a burner, \$35 for a semiautomatic control system, and \$15 for the intake tube. Oil, coal, and wood furnaces suitable for this application cost from \$300 to \$700. The cost of labor required to service the coal and wood furnaces is a considerable item.

The heating equipment should be of sufficient size to provide approximately 20 to 21 Btu per 1,000 cu ft of air for each degree the air is heated.

There is much research yet to be done in the whole field of barn curing of hay. At the present time, from the standpoint of drying with heated air, additional information is sorely needed as to the optimum relationship between temperature, volume of air, and rate of drying. The most critical unknown factor is the rate of diffusion of moisture from the interior to the surface in various types and forms of hay, at various temperatures and air velocities.

# Radiant Heating for Broiler House

By John B. Eshelman

ASSOCIATE A. S. A. E.

THIS paper will deal with the methods of poultry housing employed on our Red Rose Experimental Farms. There is and likely always will be something to learn about growing poultry and producing eggs. Just as it has been our policy to operate our feed manufacturing plant in the most efficient way, so has it been our aim to operate our Red Rose Experimental Farms in the most economical and efficient manner, saving no expense in experimenting with feeds, with raw materials, and with housing or anything else that has promise for profitable and successful farming.

We are growing in our poultry plants about 150,000 broilers annually and maintain about 4,500 laying hens. The broiler houses have been changed from the original in many ways. First, our original houses were built with ten pens to a floor, each 24x24 ft, which was the popular way of building houses at that time. Each pen would take care of 800 birds. Later we removed the partitions from these pens and ran 10,000 birds in one open house and found this, after running a number of lots, to be a great improvement. It required less labor, less expense, and less building material. The chickens were more quiet, the house was less crowded, and when the chickens were removed, the house was easy to clean. Altogether, we highly recommend this larger, open-type coop.

Second, we had too much light entering our original coops. We find that our chickens are less irritable, more peaceful, get into less trouble from picking and similar conditions, with a minimum amount of light.

Third, our original pens were ventilated through the openings, doors and windows. We experimented with forced ventilation by means of fans equipped with a thermostatic control and are now using this system with good results in all of our houses. We have found it to be more foolproof, and there have been fewer colds in the flock due to a more efficiently maintained temperature. Sudden changes in temperature and changes in the direction of air currents are not felt so keenly as when we depended upon regulating the openings for ventilation.

Last January we had a fire at the farm and our newest two-story broiler house burned to the ground. Amidst trying to locate building materials, carpenters, plumbers, etc., to build another house, we conceived the idea of using radiant floor heat instead of employing brooder stoves. Of course this radiant heat was not a scientific discovery on our part. Two

thousand years ago the Romans used a form of radiant heat at Bath, England. About forty years ago this type of heating was rediscovered in England by a man, A. H. Barker, who noticed that one of the rooms in his house was kept comfortably warm by a furnace flue which ran through the wall. Since that time radiant heating has slowly gained popularity and today it has a great future. There are several thousand dwellings, churches, and industrial plants heated in this manner now, but we believe there is only a small number of poultry houses so equipped.

Our new house was completed about three months ago. It is a two-story, asbestos shingle house, 267 ft long and 27 ft wide, with no separations or pens. The first floor ceiling is about 7 ft high and the second floor ceiling is 6 ft 9 in at the lowest point and 9 ft 3 in at the highest point. It will house from 20,000 to 25,000 broilers.

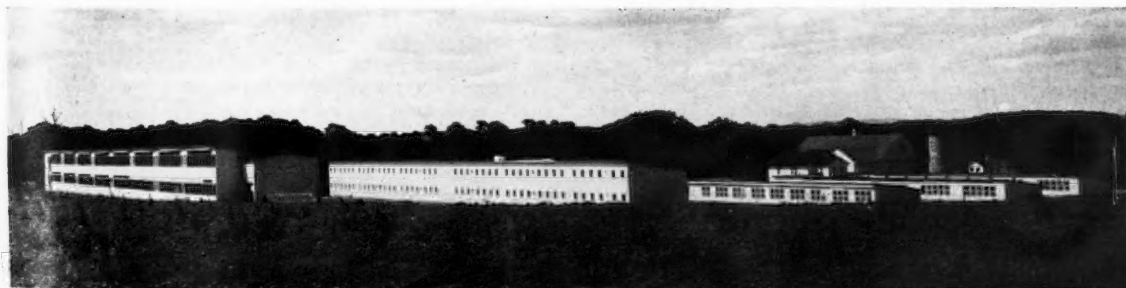
After much searching for materials, the building finally got under way and the base foundation of the recently burned house was used. This foundation was four inches of concrete. A cellar was dug just off center of the construction, measuring 30x30 ft. Here two Weil-McClain, six-section coal furnaces were installed. Each furnace is equipped with a Fuel-Saver stoker using buckwheat-sized coal. Each furnace feeds eight outgoing pipe lines from its boiler. Hot water circulates through 1 1/4-in welded steel pipes embedded in the concrete floor. The concrete covers the top of the pipes approximately 1 to 2 in. The pipe is laid 15 in apart and 7 in from the sides of the building. There are more than three miles of pipes in this house.

On one floor only, by way of illustration, are eight separate coil sections of pipe traveling lengthwise through the building. There is one Bell & Gossett 1/6-hp circulator pump for every two sections of pipe. These circulators are located on the return line and feed return water back to the boiler. Each furnace has four circulators. In the event one furnace fails or breaks down, the other furnace can be used to maintain heat in the entire building. This is manipulated by adjusting valves so that all water flows to and from one boiler. On every return line there is also a Bell & Gossett air-release valve to prevent air locks in the system. The water flows through these lines at a temperature of 120 to 125 F. Of course the weather has not been cold enough to warrant any more heat than that, but we believe the temperature will run around 135 F during colder weather. This temperature maintains room heat of 80 to 90 F.

There are four room-temperature thermostatic controls on each floor located an equal distance apart along the center of the building. Also, on each floor there are six ventilating fans,

This paper was presented at a meeting of the Pennsylvania Section of the American Society of Agricultural Engineers at State College, Pa., October 30, 1946.

JOHN B. ESHELMAN is a member of the firm of John W. Eshelman and Sons, owners and operators of Red Rose Experimental Farms.



The second building from the left in this picture is the new radiantly heated broiler house on the Eshelman farms



Left: Second story of the radiantly heated Eshelman broiler house nearing completion. Note hot water pipes in foreground • Right: Over 4,000 one-day-old baby chicks are placed in new radiantly heated broiler house

each controlled by a wafer-type thermostatic control. These are 1/6-hp, 16-in blade, four-blade, air-vent fans with high and low-speed settings.

When this building was finally started, it took only about ten weeks to complete the construction. The house was insulated at the ceiling of the top floor only. Slightly heavier joists and supports were needed to support the second story because of the weight of the pipes and cement. We raised the cement up to the second floor by means of a hydraulic lift constructed on a farm tractor.

The first flock of broilers are still in the house, and they are a little more than eight weeks old. We buy the baby chicks the same day they are hatched and their age of maturity for the broiler market is about 13 weeks. In order to prepare for the incoming baby chicks we spread a thin litter of clean peanut shells directly on the cement floor. We also put two strips of wrapping paper along the entire length of the building. On this paper we place chick grains for the first feeding and that is about the extent of our preparation. For this present flock, we purchased 28,750 chicks and placed 14,700 on the top floor and 14,050 on the bottom floor. This gave each bird approximately  $\frac{1}{2}$  sq ft at the start. Since this became more crowded as the chickens grew, we moved, at seven weeks of age, about 4,000 birds from each floor to another house equipped with brooder stoves. Of course, by this time the birds did not need any heat at all. In the meantime, we had lost 2 to 2½ per cent of the birds in the first six weeks, but at least 100 of these were cripples and had to be killed. After moving the surplus birds, the chicks then had approximately  $\frac{3}{4}$  sq ft each.

The advantages of the radiant heating system, which we have proved to ourselves, are numerous. Probably the most important advantage is that the litter is kept dry at all times; as a matter of fact, the litter is very much like a dried powder. Naturally this eliminates a breeding spot for many germs. Coccidiosis, colds, fowl cholera, and brooder pneumonia are a few of the most important diseases which are spread through damp litter. This fact in itself is enough to warrant, to us, the added cost of employing radiant heating. Coccidiosis is probably the most important of the above-mentioned diseases. When it hits the flock, it may not cause a high mortality rate, but it does retard the rapid growth of the young chicks, which is so desirable in the broiler business. It also requires medical attention in the form of a flushing mash, medicine, epsom salts, or some similar treatment. Naturally, if a flock does not encounter coccidiosis, much time and money is saved. There are other advantages, however. Because there are no brooder stoves to tend, this system is labor saving. The chicks remain spread out evenly over the floor since they do not have to get

under any brooders to keep warm. This eliminates crowding. Obviously there are no fire hazards and no carbon monoxide poison can be encountered. The litter, since it is dry, is more valuable for fertilizer. The familiar ammonia odor is practically eliminated and the actual heating cost during operation is comparable to that of brooder stoves. Mold germs cannot multiply in the dry litter and cannibalism is not encountered because there is no overheating or overlighting.

It wouldn't be fair to say that this system is perfect, however. We encountered a good deal of dust when the chickens were about three weeks old. At that age they were very active and stirred up quite a bit of the dried litter. Although the chicks had no ill effects from this, it was disturbing for a time. Another disadvantage of the system as it is installed in our poultry house is one of a technical nature. The pipes in our house are laid lengthwise along the house. Because of this, it is very difficult to heat one end of the house only. We feel that, if the pipes were installed laterally, it would be a simple matter to heat one end of the house. Of course, there are other ways by which this disadvantage could be overcome and any engineer can figure them out.

A few pertinent facts about the method of raising poultry in this new house are as follows:

There are only 3500 lb of peanut shells on one floor. In our former brooder houses we placed three tons of this material on one floor and usually added, during the growth of the chickens, up to two more tons of litter. This in itself is quite a saving.

There is 210 ft of drinking space on one floor.

There are ninety 4-ft feeders and ninety 5-ft feeders on one floor.

There are twelve 7½-w bulbs, which are lighted at night, on each floor.

There is a track used for carrying feed to the feed hoppers.

The temperature in the house itself has been maintained at about 85 to 90°F for the first week and at about 80 to 85°F for the next five weeks.

It is interesting to note that, at the same time we placed baby chicks in the radiantly heated house, we also placed chicks at the same age in another house equipped with brooder stoves. The chicks in the radiantly heated house have had absolutely no diseases whatsoever. The chicks in the brooder stove house have been flushed three times for mild attacks of coccidiosis.

All in all we believe that this modern type of house will be a great advantage to the broiler business because of the points which I have mentioned and also because of the ease of installation. We feel that the cost of such a system will soon be absorbed by added profits.

# Economics of Farm Freezers

By Lenore E. Sater

THE economics of farm freezers is a subject about which there is a great deal of controversy, and one which, I am afraid, cannot be answered simply. One only needs to talk to farm families who are using home-freezing equipment to realize that for some families the farm freezer may be an economical investment or may even become an income-producing piece of equipment, while for others it will be a luxury. Its economic value to the farm family depends on a number of factors, such as the needs of the family, the kind of equipment selected, the power rate, and the way they use the equipment. Unfortunately, few families keep records and studies to date on savings due to using home-freezing equipment indicate that most conclusions are based on family opinion rather than on actual records.

A brief study of the last OPA ceiling prices of farm-freezing equipment and the records available on operating costs along with a few simple calculations make one realize how important it is that the farm family analyze its own situation carefully before deciding upon the type of freezing facilities they will use, and the type of equipment they will purchase.

In the light of present consumer acceptance of frozen food, it seems safe to base any discussion of home freezing on the assumption that farm families will prefer to freeze that portion of the family food supply which lends itself to freezing, rather than to preserve it by other methods.

In attempting to analyze the problem, we are immediately confronted with two conditions: the farm family that does not have access to a community locker plant and the one that does.

Since the initial cost of home-freezing equipment and cost of operation vary not only with type but also with capacity, it is necessary to know the approximate freezing and frozen storage space required before a reliable comparison of the cost of using different types of freezers or a comparison of using home freezers against the locker plants can be made. This is one of the most important problems facing the manufacturer of home freezers today and a factor about which there is little information. Some authorities have attempted to calculate frozen storage requirements on the basis of the present canning practices which is about 230 qt\* per family, 35 per cent of

which is not suitable for freezing†. Allowing 30 lb per cu ft, this method of calculation gives a storage requirement of around 2½ cu ft per person. Other authorities have made their calculations on the basis of the recommended food preservation budget for an adequate diet. This method takes into consideration regional differences as the proportion of the total requirements of fruits and vegetables that will be frozen will depend largely on the length of the growing season. Specialists in New York state have estimated its growing season as approximately 4 months. This necessitates storage facilities for an 8 months' supply of fruits and vegetables. With a weekly requirement of 7½ lb, 240 lb per person will be required for the 32 weeks. If 50 per cent of the total requirement is eaten fresh or stored in other ways than freezing, 120 lb per person go into frozen storage. Because of the short growing season, New York specialists estimate that the entire amount may be in the freezer at the end of the summer season. For meat they estimate that about 75 per cent of the required 156 lb per person will be frozen and that about half, or 58 lb, will be in the freezer at one time. This makes a total of 178 lb per person to be stored. With a storage allowance of 30 lb per cu ft, 5.9 cu ft per person is required.

The few field studies which have been made on frozen storage requirements definitely show us that canning practices cannot be used as a basis for establishing frozen storage requirements. They indicate that the storage requirements based on an adequate diet may more nearly approach the present freezing requirements. For example, families in New York state say they need around 5 cu ft per person. These same studies show that the "turnover" of food in the freezer varies widely, depending on such factors as the length of the growing season, the eating habits of the family, and the management practices used by the homemaker. They also show that the quantities of food frozen increase with use of the freezing facilities. This probably is due to the higher quality of most frozen foods, to the fact that some foods such as strawberries which do not can well are excellent frozen, and the comparative ease of preparing foods for freezing.

While home-freezing practices have not been established nor have sufficient studies of present regional requirements been made to give us a figure applicable to the country as a whole, the figure of 6 cu ft per person gives us a satisfactory figure for comparing the use of different types of equipment. Let us consider first the family that does not have access to a locker plant. For a basis of comparison we will assume that an average family of four will require 24 cu ft of frozen storage space. The type of equipment the family selects



An 11-cubic-foot International Harvester freezer installed in an Iowa farm home

This paper was presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1946, as a contribution of the Rural Electric Division.

LENORE E. SATER is head, housing and household equipment division, Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture, Washington, D. C.

\*Rural Family Spending and Saving in Wartime, USDA Misc. Pub. 520 (Table II, p. 39).

†Home Preservation of Fruits and Vegetables in 1944, USDA, BAE, April, 1945 (p. 7).

should depend on the type of foods and the quantities they wish to freeze at one time. For the family that wishes to freeze only fruits, vegetables, poultry, and small quantities of pork, a chest or vertical type freezer will be satisfactory. The freezing capacity of a cabinet of this type and size is limited. Results of work in our laboratory indicate that in a 24-cu ft, chest-type cabinet not more than 40 to 50 lb should be frozen at one time. The freezing of larger loads raises the stored frozen food to temperatures considerably above 0F and for such periods of time that the quality of the stored food is lowered. Cabinets of this capacity, 23 to 25 cu ft, cost from \$400 to \$860. Of the 15 models ranging in capacity from 23 to 25 cu ft listed in the September 30, 1946 issue of "AIR CONDITIONING AND REFRIGERATION NEWS", the average OPA ceiling price was \$723. If we assume the life of the cabinet to be 10 years, interest at 4 per cent, upkeep 2 per cent, and operating cost 150 kw-hr per month at 3c, it will cost the farm family approximately \$170 a year to own and operate such a cabinet. If the turnover in the cabinet is  $1\frac{1}{2}$  times, the family will have used a little over 1000 lb of frozen food which will have cost them approximately 17c per pound for freezing and storage. If the turnover is increased to 2 times instead of  $1\frac{1}{2}$ , the cost drops to approximately 12c per pound.

If this same family wishes to freeze beef, a two-temperature, walk-in type cabinet should be selected as it provides a cooling compartment for aging. At the present time only one manufacturer lists a walk-in type with a freezing and storage section as small as 24 cu ft. While a two-temperature, walk-in cabinet will provide a temperature for aging meat, one with a 24-cu ft freezing section is subject to the same freezing load limitations as the chest or upright cabinets of that size. However, half of a beef could probably be frozen satisfactorily in a cabinet of this type because the 35-deg compartment would make possible stretching the freezing period over several days. The retail ceiling price of the one cabinet of this capacity being manufactured at the present time is \$995.

#### EXPERIENCES WITH WALK-IN CABINETS

Experiences of families who have used two-temperature walk-ins show that if they do their own butchering it is more satisfactory to have a cabinet with sufficient capacity to freeze a whole hog or a whole beef. Because of the high initial cost of commercially built walk-in cabinets with this capacity, specialists in a number of states have developed plans for home-built cabinets. In several states, cabinets of this type have been in operation 8 to 12 years and are proving highly satisfactory. The zero space in many of the cabinets ranges from 50 to 160 cu ft, with the 35 deg cooling compartments ranging from around 150 to 600 cu ft. The cost of building these cabinets varies, depending on the design, capacity, and materials used.

The State of Washington, which pioneered in this field and which I believe has as many home-built cabinets as any state in the country, reports the *prewar cost* of walk-in cabinets built by the farmer himself as follows:

Materials and refrigeration equipment for a cabinet with 50 cu ft of 0F and 425 cu ft of 35F storage—\$350 to \$500.

For a cabinet with 100 cu ft 0F and around 600 cu ft of 35F storage—\$600 (approximately).

Reports from this same state show an average energy consumption over a period of 8 years of 93 kw-hr per month for a cabinet having 72 cu ft of zeroF storage and approximately 635 cu ft of 35F storage.

Assuming prewar cost of a walk-in cabinet having 75 cu ft of zero storage and around 600 cu ft 35F storage to be \$550, on the same basis as previously calculated, it would have cost the farmer \$121 per year to own and operate. If we assume that building materials have increased 60 per cent, a similar

cabinet built today would cost around \$174 per year, or approximately the same as a commercially built 24-cu-ft chest or vertical-type cabinet. If we charge the cost of owning and operating to the zero compartment with a turnover of  $1\frac{1}{2}$  times, a cabinet of this size would make possible the storage of around 3375 lb of frozen food at a cost of 5c per pound. While the cost of owning and operating the two types of cabinets is approximately the same, the home-built, walk-in cabinet provides three times the freezing and storage capacity, and in addition provides for chilling and aging of meats. It also gives room for the short-time holding of considerable quantities of perishable food products, thus making possible prolonged use of fresh foods in the family diet and often higher quality marketable produce. In addition for the homemaker who sells fresh fruits, vegetables, poultry and dairy products in a roadside stand or local market, it makes possible the preparation of the food the day before and eliminates getting up at 2 and 3 o'clock in the morning in order to have the food fresh and ready for the 8 o'clock market. This type of home-freezing equipment because of its dual use is more apt to pay for itself and become income producing than the chest or vertical cabinet.

Now for the families that have access to the community locker plant. Their problem is threefold: (1) Shall they use the locker plant and all of its facilities, (2) shall they have their own freezing facilities and prepare their own food, or (3) shall they use a combination of the two methods? The general consensus of families who have been using locker plant facilities seems to be that in making a decision one should consider other factors in addition to cost.

As a result, let us consider the advantages and disadvantages of using the locker plant. The three chief advantages which stand out are the smaller cost per year, the elimination of work for the farm family, and less danger of spoilage of food due to a breakdown in refrigeration facilities. Twenty-four cubic feet of locker storage can be rented at a price ranging from \$40 to \$80 per year, the average being around \$50. To this must be added the cost of slaughtering, chilling, cutting, wrapping, and freezing of meat, curing and smoking hams, shoulders, bacon, etc., rendering lard, grinding sausage, the dressing, chilling, wrapping and freezing of poultry and the packaging of fruits and vegetables. One authority has estimated the cost of handling two hogs (320 lb), one beef (328 lb) and 20 chickens—a total slightly over the estimated amount to be stored for a family of four—to be about \$34, with \$8 for freezing 480 lb of fruits and vegetables.

#### COSTS OF TRANSPORTING FOOD

Next comes the cost of getting the food to and from the locker plant. Since the conventional type of household refrigerator does not provide storage space for more than a few packages of frozen food at one time, extra trips to town usually must be made to take the food to the locker and to get it home. The cost of this is difficult to estimate. If we assume 10 miles per week at 4c a mile, it comes to around \$20 per year. This makes a total cost of \$112, a money saving over using the 24-cu-ft home cabinet of around \$58 per year plus the time and energy of preparing the food. At a slightly increased cost the extra trip to town can be eliminated and greater convenience gained if the family will purchase a household refrigerator with a frozen-food compartment. These usually vary in capacity from  $1\frac{1}{2}$  to 2 cu ft and will store from 45 to 60 lb of frozen food. At the present time we do not have much information on the initial cost and cost of operation of cabinets of this type. The cost will probably be \$75 to \$100 more than the conventional refrigerator and will use around 30 kw-hr more per month. If we assume the additional cost to be \$100 and the energy consumption 30 kw-hr per month, it will cost the family (Continued on page 115)

# Conversion of Used Milk Coolers to Home Freezers

By Thomas B. Tracy

**D**URING recent years many people, particularly in the rural areas of the northern states, have converted used milk coolers to home freezer storage cabinets. These constructions have had varying degrees of success. The author has inspected several of these units in New York State, and while most of them are working satisfactorily at present, it is evident that troubles of a more or less serious nature are probable because of failure to follow certain practices.

There is an acute need for information on converting a milk cooler to frozen food storage, both to guide those planning such a construction and to forewarn those who are now using improperly converted coolers. The purpose of this paper is to point out certain fundamentals of construction which should be followed during the change-over from the milk cooler to the home freezer. If these fundamental rules are adhered to, there is no reason why a used milk cooler cannot be successfully adapted as a home freezer.

**Insulation.** In general, milk cooler cabinets are made with 3 to 3½ in of insulation in the bottom and sides and little or no insulation in the top or lid. Since milk coolers are designed to reduce the temperature of a given quantity of milk to approximately 50F (degrees Fahrenheit), and because they will be located in fairly cool surroundings, 3 in of insulation has proved adequate. However, when this same cabinet is to be used for a home freezer, the situation is quite different. Here 0F must be maintained for proper food preservation.

To insulate the frozen food cabinet effectively, at least 6 in of a good quality insulation should be used in the sides and bottom of the cabinet, and 3 to 4 in in the lid.

Insulation may be purchased in three distinct types: (1) loose fill, (2) batts, and (3) solid or sheet form. Of the three, the batt or sheet form is to be preferred for converting the milk cooler. Loose-fill insulations for a job of this kind are difficult to handle properly and have the further disadvantage that they tend to settle over a period of time.

This paper was prepared expressly for AGRICULTURAL ENGINEERING. It is based on one of the series of studies supported largely by the Buffalo Niagara Electric Power Corp., Carrier Corp., Central Hudson Gas & Electric Corp., Central New York Power Corp., Consolidated Edison Co., of New York, Long Island Lighting Co., New York Power & Light Corp., New York State Electric & Gas Corp., Rochester Gas & Electric Corp., and Staten Island Edison Corp. The studies are being carried out under the direction of a committee appointed from the staff of Cornell University, consisting of Dr. L. A. Maynard (chairman), Dean E. Lee Vincent, Dr. C. E. F. Guterman, Dr. A. J. Heinicke, and Dean S. C. Hollister.

THOMAS B. TRACY is mechanical engineer, School of Nutrition, Cornell University.

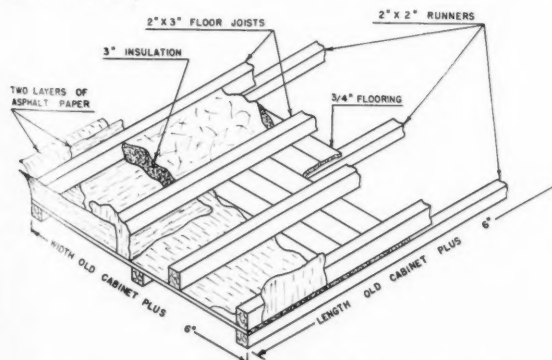


Fig. 1 Construction details of the floor of a converted milk cooler

Because the batt form is generally less expensive and just as effective as the sheet form, consideration as regards constructional details has been given this type.

**Vaporproofing.** The insulation of all the low-temperature cabinets should be lined on the *outside* or warm side with as perfect an envelope of vaporproof material as possible. Unless the insulation is so protected, water vapor from the air will flow or migrate from the warm exterior towards the cold interior. At some point in its travel, the temperature will be low enough to cause this water vapor to condense. Farther along in its travel (close to the interior) the temperature will be cold enough to form ice. And so the insulation will gradually soak up the condensed water vapor. This means a serious decrease in effectiveness of the insulating materials. Eventually it will result in an ever-increasing operating time of the condensing unit, and finally a gradual increase in the cabinet temperature.

One of the best schemes for vaporproofing employs the use of some asphalt-bonded paper. There should be two layers of this paper to insure a good vapor barrier. A good method to follow in applying this paper is to put one course of paper down and cover it with a generous application of asphalt roofing paint. When this paint has dried to a "tacky" finish, the second course of paper may be applied to the "tacky" surface just described. The second course of paper should then be covered with the asphalt paint. Following this, any corner or edge where complete overlapping of the paper is doubtful should be caulked. Any good caulking compound can be used. A good quality linoleum cement is a satisfactory substitute. Finally, the outside covering can be put on.

**Present Wet Insulation.** The foregoing points out the necessity for adding insulation and for protecting this insulation from being "soaked up" by the condensation of water vapor. One is also concerned with the insulation already present.

It is possible that the old insulation may be used as it is. By removing the sheet metal cap which covers the top plate of the cabinet and then removing one of the wooden plates, the insulation will be exposed and can be examined. If it appears wet, it is advisable to replace it or "freeze it dry."

If small holes are drilled in the inside liner of the cabinet, the moisture from the insulation will travel to the cold plates inside the cabinet forming frost on these plates. In the same way that frozen clothes dry soft on a cold winter day, so will

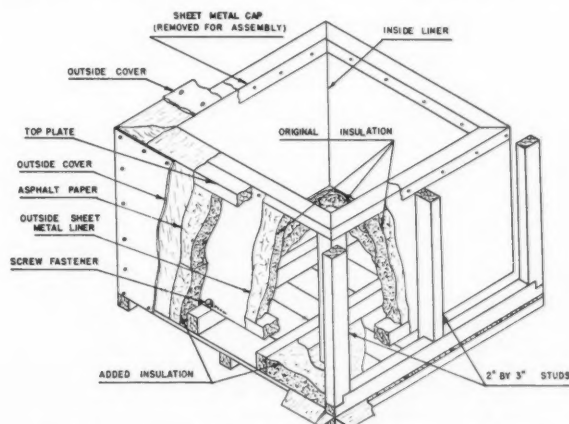


Fig. 2 Construction details of the walls of a converted milk cooler

the frozen and wet insulation dry under the conditions indicated. It may take several weeks to complete this "drying" period, during which time the plates may have to be scraped of the accumulated frost several times.

Examine the condition of the inside liner very carefully. Evidence of severe corrosion probably means that water has gone through into the insulation, creating a wet and sodden condition. It is best to remove and replace all old insulation in a case of this kind. To do this, remove the outside sheet metal liner, which will allow the old insulation to be removed easily. After replacing this with 6 in. of new insulation, there will be no need to replace the outside liner. The vaporproof paper and outside covering material will take its place.

**Adding Insulation to Interior.** It is possible to add insulation to the sides and bottom of the cabinet on the inside liner. If possible, 2-in. sheet cork should be used and fastened to the wooden frame pieces by means of 3-in. galvanized nails. The cork can be plastered and painted if desired. The disadvantage of this method is the necessary decrease in the internal volume. In a cabinet which originally measures 33x22x29 in., or 12.2 cu ft, adding insulation to the interior reduces these dimensions to 29x18x27 in., or 8.16 cu ft, a decrease of 33 per cent. If the insulation is added to the interior, the sheet metal seams of the outside liner should be soldered or caulked.

**Framing Construction to Provide Added Insulation.** The logical starting place for the necessary frame structure to hold the added insulation is the floor. Since 3 in. of insulation are to be added, the dimensions of the floor should exceed the outside bottom dimensions of the cabinet by 6 in. each way.

Referring to Fig. 1, when the flooring has been screwed to the runners, it should be generously covered by a good quality asphalt roofing paint. Meanwhile the asphalt-bonded paper should be cut into lengths sufficiently long that they will extend over the edges by at least 4 in. This will permit proper lapping of the paper which will line the outside walls. If the first layer of paper is laid down in the same direction as the floor boards, its length should be at least 8 in. greater than the width of the floor. The runners referred to are necessary because they elevate the cabinet from the floor and thus provide air circulation along the bottom.

Once the first layer of paper is in place, it should be covered with the asphalt paint, which should be given sufficient time to dry to a "tacky" finish before the second layer of paper is applied. This second layer should be put on in a direction opposite to the first layer. In a manner similar to that described for the first layer, the paper should be cut sufficiently long to provide an overhang of 4 in. When the second layer is in position, it too should be coated with the asphalt paint. The paper at each corner of the overhang should be cut out in a triangular fashion so that, when the overhanging paper is lapped upwards, there will be no wadding of paper at corners. This triangular cut should be kept small rather than too large so that no gap in the paper will appear at the corners.

The two outer floor joists should now be fastened to the floor runners by means of wood screws. The two center joists can be fastened in a similar fashion, except that flooring will be drilled for the screws which will thread into joists from underneath. All the screw holes should be filled with asphalt paint before the screws are threaded into position. This will mean that the asphalt will be carried along by the screw as it bites into the wood and successfully seal the hole in the paper which was made by the screw itself. The floor is now ready for the insulation batts which can be cut to the proper width and laid in between the joists.

The next step consists of lifting the cabinet into position so that it rests on the two center joists of the floor and so placed that the floor extends 3 in. beyond each wall of the cabinet. When the cabinet is in place, it should be securely

fastened to the center joists of the floor by nailing or screwing the bottom plate of the cabinet to the joists as indicated in Fig. 2.

The sheet metal cap should be removed from the top surface of the cabinet in preparation for the vertical framing. This consists of 2x3-in. studding toenailed to the flooring at the bottom, and a 2x3-in. horizontal top plate nailed to the top of the studs which in turn is toenailed to the top plate of the cabinet. Fig. 2 illustrates this construction in detail. It should be noted in the illustration that a shiplap joint is suggested as a sturdy construction in securing the bottom of the joists to the flooring joists. When the top plate is nailed in position, it must be even with the top plate of the cabinet to make possible a tight gasket seal when the lid is closed down. With the studs and top plate in position and securely fastened to the cabinet, the insulation can be cut and put in place. If the insulation is cut a bit longer than necessary, it can be squeezed in between the studs.

Next, the first layer of paper should be tacked in place. Again, a coating asphalt paint should be applied to the paper and allowed to dry to a "tacky" finish. Following this, the 4-in. lap of the bottom layers of paper should be bent up and adhered to the paper just put on to form a tight joint around the bottom edges. The second layer of paper should consist of vertical strips each 3 ft wide and painted with the asphalt paint as before. Both layers of paper should be so cut that there will be sufficient material to lap over the top plates of the structure. As suggested before, the corners should be cut in a triangular manner. To form a protective cover for the paper and also to provide a more attractive appearance for the cabinet, an outside wall surface should be put on. Suggested materials include scrap lumber, masonite, temper board, asbestos board, plywood, to mention a few.

**Top and Lid.** Because milk coolers rarely have insulated lids, it will be advisable to reconstruct and insulate the top and lid. At the same time, the lid might well be hinged at the back of the cabinet. This will eliminate the "split" top and lid construction which would involve great difficulty in providing a good gasket seal at the back corners of the lid. A typical method of lid construction would be a frame construction of 2x3-in. members with 3 in. of insulation squeezed in place and vaporproofed as described before. Again a covering is used on the top, bottom, and sides. Care should be observed in this construction to make sure the finished lid will be absolutely level. Finally, the gasket material should be tacked around the bottom of the lid about 1 in. from the edge. A satisfactory type of gasket to use consists of round, sponge rubber with a tacking or nailing flange.

The hinges from the old cabinet can undoubtedly be used, as well as the lid clamps. If the new lid is too heavy and awkward to handle, a system of counterweights can easily be adapted to help in raising it.

**Evaporator Plates.** Evaporator plates are manufactured in a variety of forms and sizes. The greater the surface area of these plates in any cabinet designed for 0F food storage, the better the all-round operation. Ideally, a plate should be hung on each of the four inside vertical walls and should cover the entire surface of these walls as nearly as possible. It is possible for the individual to make his own evaporator plates and thereby save quite a little against the purchase price of the manufactured article. One possible means is described in a recent bulletin, "Building a Home Freezer," by F. S. Erdman. (Cornell Ext. Bull. 705).

Before the plates are permanently in position, the refrigeration mechanic should be called in and consulted as to the method of joining each successive plate. Soldered elbow fittings should be used for each joint to insure a perfectly tight union. It is possible to solder these joints outside the cabinet and then lift the plates as an assembled unit into the cabinet

and fasten them to the walls by the fixtures provided. This method has the advantage of easier soldering of the joints, but the rather serious disadvantage of extreme awkwardness in handling several plates at one time. Once the plates are in the cabinet and properly supported, the condensing unit and the balance of the refrigeration accessories can be assembled in position and the system pumped down and charged with the refrigerant.

**Condensing Units.** It is impossible to lay down a hard and fast rule concerning the use of secondhand condensing units for low-temperature work. To obtain sufficient capacity to maintain a temperature of 0°F, it may be necessary to increase the speed of the compressor by reducing the size of the compressor pulley, or increasing the size of the motor pulley. A speed increase of at least 15 per cent may be desirable.

Before the condensing unit is put in operation, an attempt should be made to determine its condition. Generally speaking, if the unit has been in use under three years, it would be safe to put it in operation without any overhaul. Beyond three years of use, it would be wise to examine the valves and crankshaft seal and replace them if they seem worn. It would be advisable to consult a qualified refrigeration service man as to the necessity of an overhaul.

If a new condensing unit is to be purchased, a low-pressure, cut-out switch should be included. This will serve as a safety device and prevent the compressor from "throwing out" the oil if, for any reason, abnormally low suction pressures are set up. Specify a 1/4-hp low-temperature freon unit for a 2-can or 4-can cooler and a 1/2-hp low-temperature freon unit for a 6, or 8, or 12-can cooler.

**Accessory Equipment.** The dehydrator or drier is a safety device whose function is the adsorption of any water which may be present in the system. Where complete drying out is not possible, it is an inexpensive insurance policy against frozen expansion valves due to water particles remaining in the system.

For the milk cooler conversion, it is recommended that a thermostatic expansion valve be employed. The thermostatic expansion valve has been especially designed to provide protection to the compressor against any tendency to draw liquid refrigerant into it and thereby "sweep out" the oil. This valve should have a maximum closing pressure of 15 lb per sq in.

Any good thermostatic control which can be set to at least -5°F can be used for the cold control. Frequently the cold control present on the milk cooler does not have a low enough setting.

In wiring in the freezer, an ordinary switch and fuse box should be included so that the motor may be shut off manually at any time. The fuse (or preferably the fusetron) offers additional protection to the motor against any overload. In selecting the circuit for the freezer choose the one in which there are few present power appliances.

#### SUMMARY

The following points should receive careful consideration if a used milk cooler is to be converted to a home freezer:

- 1 At least 3 in of insulation should be added to the bottom and sides of the old cabinet.
- 2 All insulation should be sealed with a vaporproof covering to prevent moisture infiltration.
- 3 The top and lid of the old cabinet should be replaced by a single lid, insulated and vaporproofed with 3 to 4 in of insulation.
- 4 Small holes should be drilled in the inside liner of the cabinet to permit the old insulation to dry out.
- 5 The used condensing unit should have new valves and a new crankshaft seal if it has been in operation over three years. (This refers to an open-type unit.)
- 6 Compressor speed should be increased about 15 per cent.

7 A thermostatic expansion valve should be used in preference to an automatic valve.

8 A separate switch and fuse box should be used.

9 The cabinet should be elevated from the floor by means of runners.

## Economics of Farm Freezers

(Continued from page 112)

\$26.80 per year for a cabinet with the frozen-food compartment or around 1 1/4¢ per day for the added convenience.

Now for the disadvantages. The one most frequently mentioned is the inconvenience of having a major portion of the food supply stored out of the home. Even with the best of planning, conditions arise which require food not planned for. Occasionally this can be taken care of by an extra trip to the locker plant, but when guests arrive unexpectedly this is not always possible. The second complaint is the quality of the food. Some plants do not maintain low enough temperatures to insure high-quality frozen products. Also many do not have the capacity or realize the importance of handling rapidly the food as it comes to the locker plant. For high quality in frozen fruits and vegetables, they must be picked at the right stage of maturity and put into the freezer quickly. Since few locker plants will prepare fruits and vegetables for freezing, the homemaker must prepare and package them in her own kitchen and take them to the plant for freezing. Most farm gardens and orchards are not of sufficient size to have large quantities of vegetables and fruits maturing or ripening at the same time. This necessitates almost daily trips to the locker during the processing season if very high-quality products are to be obtained. Rarely is this done and as a result poorer quality products go into the freezer and poorer quality comes out.

The two outstanding advantages of home-freezing facilities over the locker plant are convenience and greater assurance of quality in the frozen fruits and vegetables. The disadvantages are higher cost and more danger of food loss due to breakdown in refrigeration facilities. If we balance all the factors, the combined use of locker plant and home freezer seems to be the answer. For example, if a 6 cu-ft home cabinet had a separate freezing compartment it would probably provide adequate capacity and space for freezing the quantity of fruits and vegetables maturing each day and for storing them until they were taken to the locker. After the processing season is over, it would provide ample storage for a number of packages of each type of food frozen and space for freezing leftovers and cooked foods. Six cubic foot cabinets range in price from \$200 to \$335, with an average price of \$298. With an operating cost of around 70 kw-hr per month a cabinet of this size would cost approximately \$73 per year to own and operate. Supplementing the home freezer with 3 lockers at \$12.50 per locker and the facilities of the locker plant for handling meat, and assuming the trips to the locker to be cut in half, the total cost to the farmer would be around \$155. This is a little over 80¢ per week for the higher quality of fruits and vegetables as a result of more rapid handling from garden or orchard to freezer, and for the added convenience and satisfaction resulting from having an ample supply of frozen food at home. While theoretically this seems the answer to what is the most economical and satisfactory method of home freezing, in actual practice it may not prove to be. Unofficial reports of a study now under way where such a combination of facilities are being used indicate that farmers are not satisfied with the small cabinet but prefer at least half or more of the storage facilities in the home. Such results lead one to the conclusion that many farm families are not so interested in the cost of freezing facilities in terms of dollars and cents as they are in the intangible returns in convenience and satisfaction which are difficult to evaluate.

## RESEARCH NOTES

(A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.)

UNDER this heading in AGRICULTURAL ENGINEERING for January, it was reported that Alfred D. Edgar, engineer of the USDA Division of Farm Buildings and Rural Housing, was in Alaska investigating agricultural engineering research problems under winter conditions. He is now back in the States and has just resumed work on the potato storage studies at Ft. Collins, Colo. With the other members of the Alaska task force, Edgar is preparing the official report on findings of the expedition.

Farming in Alaska is being considered as an auxiliary to military, transportation, fisheries, forestry, and industrial development. Edgar reports that farms are small and mechanization is essential because of the high cost of labor and the difficulty of providing adequate feed and shelter for work animals. Most settlers do truck farming, which of course requires diversified machinery. Special types of land-clearing machinery have been developed. Much potential agricultural land is covered with a thick stand of brush and land clearing is heavy work, costing \$25 to \$50 an acre. In general it is done gradually by the individual farmer.

Frozen subsoil in Alaska presents problems in connection with land preparation, machinery, and structures. Erosion is unusually bad. Ice in the upper strata tends to thaw downward rather than sideways. Thawing following land clearing makes for very uneven fields. Sometimes underground melting results in pockets and crevasses which are a hazard to workers, animals, and machinery. Steeper slopes thaw out first and are usually planted to the earlier crops, but this increases the erosion hazard. Heating of buildings located on frozen ground sometimes causes the floor to sink as much as a foot as the ice below melts. This is an illustration of the structural problems encountered in the Territory.

Depth and quality of soil vary greatly and relatively few portions of the Territory have a climate suitable for farming. A fair variety of truck crops is grown, however. Strawberries, for instance, do very well at Fairbanks in the Tanana Valley. Peas for canning have proved to be a valuable cash crop that is well adapted, particularly to the Matanuska Valley, where there are 300 full-time farms. A large percentage of the farm homes have greenhouses in which tomatoes and cucumbers are raised.

Immediate research programs of agricultural engineering interest are potato storage ventilation and dairy barn ventilation. Work is centered at the experiment station at Palmer, where Edgar had his winter headquarters.

In addition to much valuable data on the agricultural research and development needs of Alaska, the task force brought back striking color photographs, many of them taken under the difficult light and temperature conditions of winter in the far north. Edgar considered himself fortunate, in view of the observations he wanted to make, to be in Fairbanks for the coldest weather the town has had since 1935-36. Three planes crash-landed in the takeoff at Todd Field the week of December 10 because the oil heating systems of multimotored planes are inadequate for ground temperatures ranging from -32 to -56°F. Automobile engines must be kept going constantly in such weather. Edgar's trip included 80 hr by air and 12 hr by train, in addition to the 5,000 miles covered by automobile.

In North Carolina alone, 1,412 tobacco barns burned during 1946, costing farmers an estimated 20 million dollars. To cut back this loss is one of the objectives of the USDA-North Carolina Agricultural Experiment Station cooperative research program on flue-cured tobacco mentioned in "Research Notes" in AGRICULTURAL ENGINEERING for January. There are many variables which must be considered, such as building construction, insulation and ventilation, type of fuel, furnace, and burner. An examination into the causes of tobacco barn fires indicates that manual control of heating is frequently to blame. The contribution of electricity to farm efficiency is being extended in still another direction through the development of automatic controls for stokers and fans.

The work started last season and centered at Oxford, N. C., under Dr. O. A. Brown as the USDA agricultural engineer, will be intensified this year by parallel investigations in cooperation with the Georgia Coastal Plain Experiment Station at Tifton. This station is located in the extreme southern part of the state where the high-quality, shade-grown tobacco used for cigar wrappers overlaps the bright-leaf tobacco sold for cigarettes. Since tobacco growers in southern Georgia are through curing their crop before North Carolina growers begin, it will be possible to get research results from curing operations over a longer period each year.

In addition to the curing studies, Dr. Brown and his co-workers at Oxford will attempt to establish standards for the use of artificial light (fluorescent or other) in grading. Color of the leaf is still the main, though not the only, factor governing prices paid at tobacco auctions, and grading is still done in most warehouses under natural daylight. Reliable and accepted standards for artificial light will make grading independent of weather conditions.

Other phases of tobacco production will be investigated under a cooperative project just being established by the BPISAE Agricultural Engineering Divisions and the University of Maryland agricultural experiment station and extension service. J. W. Rockey is the USDA engineer assigned to study engineering aspects of labor utilization efficiency in the production and handling of southern Maryland tobacco. Harry L. Carver is in charge of this and other work simplification studies.

Light, air-cured tobacco (Type 32) is grown on about 40,000 acres in five counties of southern Maryland. It is an essential ingredient of tobacco blends for cigarettes because of its special burning qualities. The complicated processes involved in carrying the tobacco from seed-bed to preparation for market are still done largely by hand labor, and a dwindling labor supply has forced growers to seek help in mechanization where feasible and in more efficient use of labor.

There are significant labor problems in most phases of the production and handling of this type of tobacco, and an engineering approach to each phase is anticipated under the new project. Examples of different methods will be compared as to costs and effectiveness in time and labor studies. Control of temperature and humidity in barns is a major problem, as growers are now at the mercy of the weather and very serious losses are suffered whenever unfavorable weather occurs during critical stages of the curing period.

The worst labor bottlenecks are in the harvesting and hanging period. Objectives of the new work include devising and developing labor-saving equipment, improvement of handling procedures, and possible redesign of curing barns.

Preliminary testing has started on the completed one of two poultry calorimeters in the cooperative poultry housing research project of the Bureau of Animal Industry and the BPISAE Division of Farm Buildings and Rural Housing at Beltsville, Md. The test unit is located in a refrigerated room, which will permit study of a wide range of temperatures. It has isothermal walls of sheet copper surrounded by an insulated wall with thermostatically controlled cooling and heating coils between.

The over-all objective of the study, as of parallel studies on swine housing in California and dairy cattle housing in Missouri, is the effects of environmental factors on production. Temperature, humidity, air circulation, light, and space will be tested.

Heat and moisture production of the birds are main indicators of their metabolism under varying environmental conditions, and the calorimeter is set up for continuous recording of these data. Gaseous exchange is analyzed by means of an "absorption train". An interesting item of specialized equipment for the calorimeter was devised and constructed by Engineer J. R. Vincent. It is an automatic scales for weighing and recording a continuous flow of calorimeter fluid.

Use of bactericidal lamps in poultry houses has been under investigation at the USDA Agricultural Research Center, Beltsville, Md., by the Poultry Nutrition Section of the Bureau of Animal Industry. During the coming year the Agricultural Engineering Divisions will cooperate in this research, which is aimed at reduction in disease and mortality among laying hens. L. G. Schoenleber of the Division of Farm Electrification (BPISAE) has been assigned as engineer on the project.

An insecticide and fungicide duster and feeding mechanism developed by USDA agricultural engineers working on pest and plant disease control equipment delivers dust to the nozzles with a maximum variation of only 3 per cent regardless of the height of dust in the hoppers. In commercial machines tests showed variations in delivery varying from 50 to 300 per cent. Uniformity of dust delivery is essential for effective control of both pests and diseases. With the new equipment the maximum air delivery of 220 cubic feet per minute per tube is more than twice the air volume delivery commonly found.

Use of the rotary hoe in cotton, investigated by USDA agricultural engineers in experiments looking to mechanization of this crop and including use of flame weeding and other new developments, was found to make possible cultivation of small two-leaved cotton at speeds of 5½ miles an hour. Used primarily for weed control, cultivation with the rotary hoe also was found to have marked effect in controlling damping-off of young cotton plants by breaking up soil crusts so as to allow oxygen to penetrate. Oxygen stimulates root growth and discourages development of the damping-off fungus.

(Continued on page 120)

# CROP INSURANCE

BY THE

GALLON

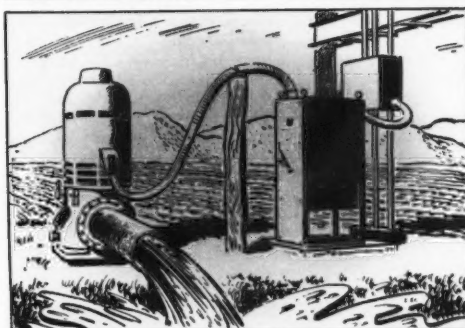


**T**O PROTECT precious crops, more electrically driven pumps will go into operation this year than ever before in this nation's history. Even in the so-called "humid" areas, far-sighted farmers will be prepared for that summer dry spell when thriving crops would otherwise shrivel under a hot sun and the year's income shrivel with them. These farmers know it's the bumper crop that pays over and above the cost of seed and fertilizer, equipment and labor, and they want to eliminate removable risks. That's why they choose a dependable motor-driven pump for crop insurance.

## WHY DO FARMERS CHOOSE GENERAL ELECTRIC MOTORS?

There's a type of irrigation for every type of land and crop. There is also a wide selection of pumps and motors to do the job. And General Electric has engineered and built equipment that won't fail when you need it most. G-E motors have been specially designed so there is no danger of oil draining away from bearings, or dirt entering the bearings during the period when they are not in use. The motors give full-rated horsepower at the flick of a switch—no need to tinker with parts or turn over a heavy engine. They're quiet running, and with G-E control they can be automatic and have complete overload protection—there'll be no danger of burning out the motor if something goes wrong with the water system. *Many G-E pump motors have more than twenty-five years of service behind them, and they're still going strong!*

G-E standardized designs work perfectly with all types of pumps. Select the right motor for the right pump in the right location, and you'll get lifetime service—when the motor is General Electric. *Farm Industry Division, General Electric Company, Schenectady 5, N. Y.*



**GENERAL  ELECTRIC**

## NEWS SECTION

### Schwalen New Chairman Pacific Coast Section

**H.** C. SCHWALEN, head, agricultural engineering department, University of Arizona, was elected chairman for the ensuing year of the Pacific Coast Section of the American Society of Agricultural Engineers at its 25th annual meeting held at Davis, Calif., February 7 and 8. Roy Bainer, agricultural engineer, was elected vice-chairman, Walter W. Weir, drainage engineer, division of soils, was re-elected secretary-treasurer, and C. N. Johnston was elected a member of the Executive Committee, all of the University of California. The new Nominating Committee of the Section includes A. A. Armer, Spreckles Sugar Co., L. M. K. Boelter, University of California at Los Angeles, and C. H. Milligan, Utah State Agricultural College.

The Section meeting was held jointly with the 15th Annual Farm Machinery Conference sponsored by the division of agricultural engineering of the University of California. Nearly 300 persons were registered at the meeting, and an excellent program of technical papers was presented.

### J. L. Shepherd to Represent A.S.A.E.

**A**T THE request of the National Peanut Council to nominate a member of the American Society of Agricultural Engineers to serve as one of the judges for making the annual award to be offered by the Council for outstanding contributions to the peanut industry, A.S.A.E. President Mark L. Nichols has nominated James L. Shepherd, research agricultural engineer, Georgia Coastal Plain Experiment Station, to serve as the nominee of the Society.

### Missouri Section to Meet in April

**A** MEETING of the Missouri Section of the American Society of Agricultural Engineers has been scheduled to be held at Kansas City, Missouri, April 17 to 19. It will start on the evening of April 17 with a dinner in conjunction with the Kansas City Tractor Club. Marion W. Clark, extension agricultural engineer, University of Missouri, is to address the group on the subject "The Plan for Water Management on Missouri Farms." A moving picture, "The Years at the Spring in Missouri," is also scheduled.

"The Need for Agricultural Engineering in Missouri" is the subject for a panel discussion, led by J. C. Wooley, on the following forenoon, April 18. It is to be followed by a talk by Paul M. Mulliken, executive secretary, National Retail Farm Equipment Association.

Dr. M. L. Nichols, president of the American Society of Agricultural Engineers, and Raymond Olney, secretary, have been invited to address a luncheon meeting the same day. A trip to neighboring manufacturing plants has been scheduled for the afternoon. A dinner the same evening is to be addressed by Dr. Harold A. Vagtberg, on the work of the Midwest Research Institute, of which he is president.

A visit to the Midwest Research Institute has been arranged for Saturday forenoon, April 19.

### Industry-Research Conference

**A**N INDUSTRY-RESEARCH conference sponsored jointly by the Farm Equipment Institute and the divisions of agricultural engineering, (BPISAE), U.S. Department of Agriculture, was held at the agricultural research center, Beltsville, Maryland, March 3, 4, and 5.

The conference was opened in the administration building of the Department of Agriculture in Washington with an introduction and statement of purpose, by A. W. Turner; a welcome by the Hon. Clinton P. Anderson, Secretary of Agriculture, and a response by W. A. Roberts, president of the Farm Equipment Institute.

At Beltsville the program continued with presentation of the research in progress, covering projects in the F.E.I. research outline and others with present or prospective bearing on farm equipment design and use requirements.

The concluding day was reserved for men from industry to discuss individual problems with various members of the Department staff at Beltsville.

### Michigan Area Section Meeting

**A** ONE-DAY meeting of the new Michigan Area Section of the American Society of Agricultural Engineers on March 1, at Michigan State College drew nearly 100 members and guests from the state, the Toledo area, and western Ontario.

The opening program feature was an explanation of the new radiant-energy, frost-control unit which has attracted world-wide attention, and of the research applied to its development. This was reported by A. W. Farrall, head of the agricultural engineering department at

### A.S.A.E. Meetings Calendar

- April 4 and 5—Southwest Section, Grim Hotel, Texarkana, Texas.
- May 16 and 17—Virginia Section, Hotel Roanoke, Roanoke, Virginia.
- June 23 to 25—ANNUAL MEETING, Benjamin Franklin Hotel, Philadelphia.
- October 23 and 24—Pacific Northwest Section, Davenport Hotel, Spokane, Wash.
- December 15 to 17—FALL MEETING, Stevens Hotel, Chicago.

Michigan State College, and F. J. Hassler, graduate assistant.

Another feature of the forenoon program was a symposium on the use of chemicals in agriculture, with contributions on weed control by Mr. Dutton of the Dow Chemical Co.; A. H. Graves, agricultural engineer, U. S. Department of Agriculture, on insect and plant disease control; and J. W. Shields, agricultural representative of the U. S. Rubber Co., who presented a paper for Dr. McNew, head of the agricultural chemical research laboratory of the company.

A noon luncheon was followed by a panel discussion on the possibilities for agricultural engineers in Michigan. Dan M. Guy led the discussion and called on David B. Poor to present the farm structures viewpoint; Frank W. Peikert, soil and water; H. J. Gallagher, rural electrification; and J. W. Shields and D. A. Milligan, power and machinery.

Director V. R. Gardiner of the Michigan Agricultural Experiment Station and Dean H. B. Dirks of the college of engineering were guests at a part of the meeting and indicated briefly their keen interest in agricultural engineering.

Frank W. Peikert, vice-chairman of the Section, presided at the morning session and Harold E. Pinches, Section chairman, presided at the luncheon session.

The meeting concluded with a brief explanation by Mr. Farrall of the agricultural engineering department organization, work, and progress on the new agricultural engineering building under construction; and a campus tour passing the temporary housing area and the new agricultural engineering building, with stops at the frost-control setup and the present agricultural engineering department.

David B. Poor was named to fill the vacancy in the office of secretary-treasurer of the Section, created by W. O. Murphy having moved out of the Section area.

### National Chemurgic Conference

**"NEW** Riches from the Soil" will be the keynote of the 12th Annual National Chemurgic Conference to be held at the Skirvin Hotel, Oklahoma City, Okla., March 26 to 29, 1947.

A.S.A.E. members on the program include Wheeler McMillen, president, National Farm Chemurgic Council; Paul M. Mulliken, executive secretary, National Retail Farm Equipment Association; George Krieger, manager, agricultural division, Ethyl Corporation; Donald M. Crooks, midwestern representative, Douglas Fir Plywood Assn.; L. F. Livingston, manager, extension division, E. I. du Pont de Nemours and Co.; Paul N. Doll, agricultural engineer, Missouri Department of Resources and Development, and Arnold P. Yerkes, in charge of farm practice research, International Harvester Co.

Conference sessions will open with a noon luncheon on March 26, presided over by the Hon. Roy Turner, governor of Oklahoma, and with Mr. McMillen as the speaker. The Hon. Val Peterson, governor of Nebraska, is to address the annual dinner on the evening of March 28.

Particularly featured conference subjects include petroleum and agriculture, forests and forest products, and specialty crops and agricultural wastes.

Preregistrations are being accepted by the National Farm Chemurgic Council, Station A, Box 397, Columbus 1, Ohio.

### Second Phase of China Project Started

**F**OLLOWING months of preliminary preparation in this country, J. Brownlee Davidson, Archie A. Stone, Howard F. McColly, and Edwin L. Hansen sailed for China in January as the "Committee on Agricultural Engineering" to work in the National Agricultural Research Bureau of China's Ministry of Agriculture and Forestry. Their work in China is to continue for three years.

Dr. Davidson, as head of the committee, will direct and coordinate agricultural engineering research and education to be started by the Bureau. Mr. McColly is to assist him. (Continued on page 120)

# IH and the IH dealer will do their level best for farmers in 1947!

ONLY one thing is *new* in that headline. International Harvester and the IH dealers have been doing their *level best* for generations in the interest of American agriculture.

So what's new in it? Well—there's that figure 1947. A brand-new season is coming up, and we believe that things are going to be a lot different.

In recent years, "level best" hasn't been good enough. . . . In every community in the land the farmers have been repairing and mending old equipment, and getting by—waiting in line at every dealer's door with patience and tempers wearing mighty thin. . . . Right this minute a thousand farmers are asking "When's my tractor coming, and those new machines that were promised me months ago?" It has been hard to take—for farmer and dealer and manufacturer alike.

Every farm operator knows that the Harvester Company has perfected many new products, competently engineered and tested, fully qualified to take to the fields. . . . Our problem now is to turn them out in quantity production for our millions of customers, from long established plants and from many new factories. Our hope for this new year is to keep assembly lines running without interruption until every man's need is satisfied.

The farmer who wants *competent winter service work* and the *latest news* about new equipment will be sure to see his International Harvester Dealer.



**INTERNATIONAL HARVESTER COMPANY**  
180 North Michigan Avenue Chicago 1, Illinois

Remember that "FARMALL" is a registered trademark—Farmalls are made only by International Harvester.

## INTERNATIONAL HARVESTER

### Power Farming Equipment



Above: International Mechanical Cotton Picker. New plant under construction at Memphis, Tenn., will build this machine in limited numbers this year.



Above: McCormick-Deering 123-SP Self-Propelled Combine. Other coming International developments: smaller combines, tractor touch-control, refrigeration.



Above: McCormick-Deering One-Man Pickup Twine Baler. Many other new hay machines are in various stages of development by International Harvester engineers.



Above: The New International No. 24 2-Row Tractor-Mounted Corn Picker. Coming International machines include new 1-row corn pickers and cut-off corn pickers.

## NEWS SECTION

(Continued from page 118)

primarily in the fields of research and soil and water technology. Mr. Stone, in the power and machinery field, will conduct research and teach at the National Central University. Mr. Hansen will handle farm structures research and teach at Nanking University.

P. W. Tsou, of the Ministry of Agriculture and Forestry, has a thirteen-point program directly utilizing agricultural engineering in land utilization and soil conservation, increasing agricultural land, increasing production per unit area, improvement of farm implements, and promotion of rural industries. Agricultural engineering will also be a factor in most of the other eight points applying to specific lines of production and development.

Y. C. James Yen, noted originator of the simplified Chinese alphabet and mass education in China, has represented Mr. Tsou in the United States in obtaining technical and financial assistance for the project.

Through the cooperation and financing of the International Harvester Company, Mr. Yen located the agricultural engineers to serve on the Committee, assisted in their advance planning and preparation for the mission, and arranged for equipment to be used in the researches in China. Also with the cooperation of the International Harvester Company, he has twenty Chinese students studying agricultural engineering in this country, in preparation to carry on the work being started by the Committee.

The Committee's four primary objectives are to help Chinese farmers improve the quantity and quality of their products, reduce the cost of their production, and improve their living conditions.

## RESEARCH NOTES

(Continued from page 116)

**Electrocuting Corn Borers.** The effectiveness of light traps for control of the European corn borer will be studied at Purdue University Agricultural Experiment Station as part of a new farm electrification project cooperative with USDA, continuing work which yielded promising results before the war. John G. Taylor, who comes to the field staff of the USDA Division of Farm Electrification from REA, will handle the work at Lafayette in cooperation with entomologists of the Purdue Station.

Destruction of corn crop residues as a means of corn borer control requires the cooperative support of all corn growers in a locality. The

chief cultural method of control recommended for the individual grower has been delayed planting. Sweet corn growers, however, commonly make a series of plantings, and their use of delayed planting has been greatly complicated by the appearance, in Indiana particularly, of a second brood of corn borers late in the season. Preliminary light-trap investigations were started in 1935 in the search for a control measure to supplement spraying or dusting.

AGRICULTURAL ENGINEERING carried reports of the Purdue work in its issues of April, 1939, and March, 1940. Studies now beginning will investigate improved trap designs and experiment with fluorescent lamps and some of the more recently developed lamps. Intensity seems to be a more important factor than color in attracting the insects to light, although a color difference has been noted in favor of the blue end of the spectrum. The research should determine the conditions under which use of light traps to protect valuable crops of sweet corn and hybrid seed corn from heavy loss is effective and economically practical.

Taylor and the cooperators at Purdue hope also to work on the electrical heating of beehives during the winter, thus attacking one of the major problems of beekeepers.

A graduate of Pennsylvania State College in agricultural engineering and an A.S.A.E. member, Taylor received intensive training in electronics at the Illinois Institute of Technology with the U. S. Army Signal Corps and saw active service in World War II in the Pacific theater as a radar technician.

\* \* \* \*

**Machines Harvested Large Sugar Beet Acreage.** The 1946 sugar beet harvest was characterized by a great advance in mechanization. Early in the year it was estimated, on the basis of manufacturers' intentions as to machine production, that about 1,400 mechanical beet harvesters would be available. Five manufacturers were planning to have harvesters in the field. In California it was estimated 60 per cent of the total beet acreage would be harvested with machines. Only 5 years ago there were no mechanical harvesters in use, and only 100 in 1943.

The Division of Farm Power and Machinery, USDA, carries on sugar beet mechanization studies at Fort Collins, Colo., under Engineer S. W. McBirney, and at East Lansing, Mich., under George W. French. Several developments from these studies, including the disk topper, sorting table for separating beets from clods of heavier soils, and a variable-cut topping and driven-wheel finder were incorporated into the design of sugar beet harvesters built in 1946. For stories on three of the four major types of harvesters now in production, see AGRICULTURAL ENGINEERING for December, 1946.

*Depend on*  
**RILCO RAFTERS**  
*for Structurally Sound Farm Buildings*



● Rilco Rafters are glued laminated framing members, factory-fabricated of selected and seasoned lumber.

They are engineered to provide strength, wind resistance and streamlined modern appearance to all types of farm buildings. Tests prove that glued laminated rafters are four times stronger than nailed rafters.

Designed and factory-built ready for quick erection Rilco Rafters offer important economies in time and money.

Rilco Rafters combine wall and roof framing into a single strong unit eliminating the weak joint between sidewall and roof framing. Interiors of Rilco buildings are free of objectionable posts and braces. Such construction is ideal for installation of a barn hay drier.

Investigate the possibilities of improved farm construction with Rilco Rafters. Get in touch with your nearest Rilco representative or write to—Rilco Laminated Products, Inc., 1394 First National Bank Bldg., St. Paul 1, Minnesota. Eastern Division: 221 Conyngham Ave., Wilkes-Barre, Pa. Western Division: Sutherlin, Oregon.



BARN



BROODER HOUSE



GRANARY



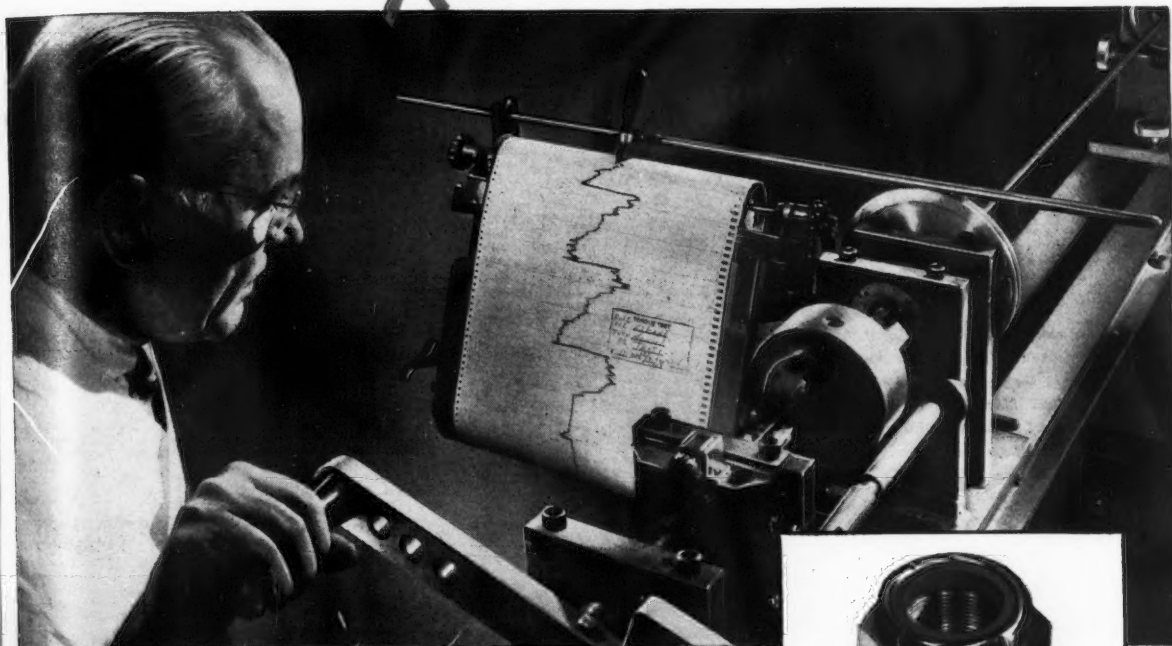
MACHINE SHED

**RILCO** DESIGNERS AND FABRICATORS  
 OF ENGINEERED WOOD PRODUCTS  
 FOR A WIDE VARIETY OF USES.

## A-N TORQUE TESTS

*Prove  
Reusability*

## OF ELASTIC STOP NUTS



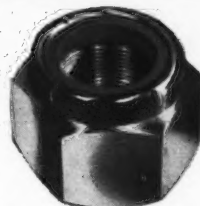
*—the Red Elastic Collar provides  
dependable locking torque for RE-USE!*

Army and Navy specifications for aircraft lock nuts include a specific torque test to prove locking effectiveness. Lock nuts have to maintain adequate locking torque through 15 on-and-off cycles.

ESNA Elastic Stop Nuts—with the Red Elastic Collar that has become a symbol of security to all aviation engineers—remain self-locking against Vibration, Impact and Stress Reversal in both pre-stressed and positioned settings.

In addition, the self-locking, self-sealing and reusable Red Elastic Collar protects the bolt. It does not deform the bolt, damage the threads or gall the finish.

Reusable ESNA Elastic Stop Nuts provide dependable protection against Vibration, Thread Corrosion, Thread Failure, and Liquid Seepage. This multiple protection—which has made Elastic Stop Nuts the standard fastener on many products—also achieves the double economy of inventory simplification and reduced procurement costs. ESNA engineers are now ready to study your fastener problems. Address: Elastic Stop Nut Corporation of America, Union, New Jersey. Sales Engineers and Distributors are conveniently located in many principal cities.



**The RED ELASTIC COLLAR**

—denoting an ESNA product—

... is threadless and dependably elastic. Every bolt—regardless of commercial tolerances—impresses (does not cut) its full thread contact in the Red Elastic Collar to fully grip the bolt threads. In addition, this threading action properly seats the metal threads—and eliminates all axial play between bolt and nut threads.

Torque tests—for Elastic Stop Nuts—are based on a steel-to-steel frictional coefficient of .18. Bolt loadings are figured at 40,000 psi for commercial bolts; 90,000 psi for aircraft bolts.



## ELASTIC STOP NUTS



INTERNAL  
WRENCHING



ANCHOR



WING



SPLINE



CLINCH



GANG  
CHANNEL



CAP

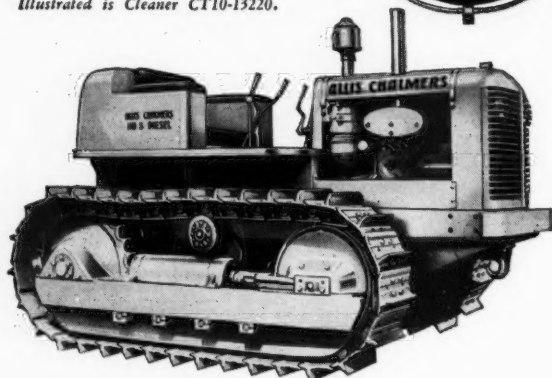
PRODUCTS OF: ELASTIC STOP NUT CORPORATION OF AMERICA

# UNITED AIR CLEANER

## PROTECTS NEWEST TRACTOR!

Engineered completely new throughout, Allis-Chalmers Model HD-5 crawler tractor is claimed to be the most advanced tractor in its power class. Like its larger "brothers," its 2-Cycle Diesel, 37 d.b.p. engine is equipped with United Oil Bath Air Cleaner.

Illustrated is Cleaner CT10-13220.



No internal combustion engine is continuously subjected to more dust and other destructive abrasives than the power plant of a track-type tractor used in roadbuilding and other construction work.

To afford maximum protection, Allis-Chalmers has for years used United Oil Bath Air Cleaners on its 2-Cycle Diesel crawler tractors. Recently announced, the brand new HD-5 tractor is similarly equipped with United Air Cleaner protection.

Engine guardians for over 25 years, United Oil Bath Air Cleaners have extended the operating life and increased the efficiency of millions of engines in a variety of applications — in passenger cars, trucks, busses, tractors, farm equipment and stationary power plants.

There are over 260 United Air Cleaner models — each built for specific engine requirements. We invite you to discuss your design and installation problems with our sales engineers.

### UNITED SPECIALTIES COMPANY

United Air Cleaner Div., Chicago 28 • Mitchell Div., Philadelphia 36

AIR CLEANERS ★ WHEEL GOODS ★ METAL  
STAMPINGS ★ DOVETAILS ★ IGNITION AND  
DIRECTIONAL SIGNAL SWITCHES ★ ROLLED SHAPES

### Personals of A.S.A.E. Members

*W. J. R. Browder* recently resigned as extension agricultural engineer at the University of Tennessee to accept a similar position with the agricultural extension service of the University of Arkansas at Little Rock.

*Donald Christy* was elected vice-president of the Kansas State Association of Soil Conservation District Supervisors at the Association's recent annual meeting. Mr. Christy is also chairman of the Scott County Soil Conservation District.

*Howard H. Engelbrecht*, who served as an officer in the Army Air Forces during the war, is now a graduate student at Iowa State College, specializing in agricultural climatology.

*Norman A. Evans*, who served in the armed forces during the war, is now a graduate student in agricultural engineering at the Utah State Agricultural College, Logan.

*Julian M. Fore*, formerly head of the farmstead engineering unit, research section, agricultural engineering development division, Tennessee Valley Authority, was recently named as head of the education section of the division, succeeding Nolan Mitchell.

*Reuben R. Garrard*, after extended service as an officer in the U. S. Army Air Forces during and since the war, is now employed as a junior soil conservationist with the Soil Conservation Service, USDA, and is located at Hartwell, Georgia.

*R. W. Hantzenroeder* has resigned as chief engineer, tractor division, The Fate-Root-Heath Co., to accept a position as project engineer on tractors with Harry Ferguson, Inc.

*A. T. Hendrix*, formerly head, farm processing unit, research section, agricultural engineering development division, Tennessee Valley Authority, has been named head of the research section, succeeding John A. Schaller.

*Joe P. Hollingsworth*, who served as a lieutenant in the U. S. Naval Reserves during the war, is now employed as research assistant in rural electrification in the agricultural engineering department of the A. & M. College of Texas.

*Earl G. Johnson* has taken leave of absence from his present duties as zone conservationist (Region 5), Soil Conservation Service, U. S. Department of Agriculture, to accept a temporary appointment with UNRRA on an assignment to China. The particular territory to which it is expected he will be assigned is the flooded area in Honan and Anhwei provinces. One of the jobs undertaken by UNRRA is to rehabilitate this area for flood protection. Mr. Johnson's assignment is for a period of about six months.

*Daniel E. Kirk*, who served as an ensign on naval ordnance in the U. S. Naval Reserves during the war, is now assistant agricultural engineer on the agricultural engineering staff of Oregon State College. He will be engaged on part-time teaching and general research.

*Gerald L. Kline*, who served as a liaison pilot of field artillery in the Army during the war, is now employed in the engineering department of the La Crosse, Wisconsin, works of Allis-Chalmers Mfg. Co.

*Charles S. Morrison* recently resigned as research fellow in agricultural engineering at Iowa State College and is now engaged in weed control research in the experimental department of Deere & Company at Moline, Illinois.

*William H. Paraday*, who served as a captain in the 6th Cavalry of the U. S. Army during the war, is now associated with the Florida State Department of Education as veteran teacher of vocational agriculture at Jennings, Fla.

*V. S. Peterson*, central-western district manager, extension division, E. I. du Pont de Nemours and Co., recently addressed the Lions Club of St. Joseph, Michigan, and visited the A.S.A.E. headquarters.

*A. H. Scrimshaw*, who served with the Royal Canadian Air Force during the war, has been appointed experimental officer, effective April 1, at the National Institute of Agricultural Engineering at Askham Bryan, York, England.

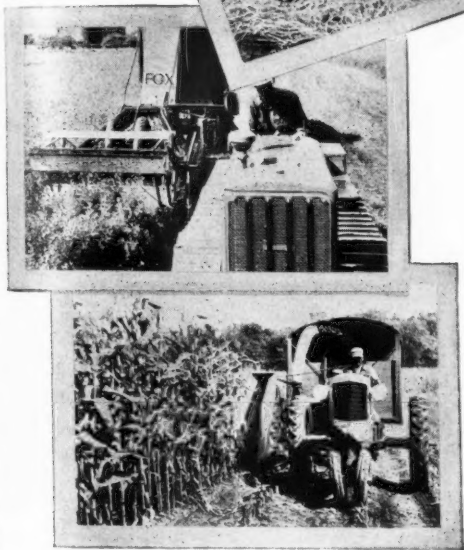
*Charles C. Worstell*, until recently a design engineer at the Rock Island Works of J. I. Case Company, is now manager of the C. W. Company at Princeton, Iowa.

### Necrology

HERMAN MOSCHEL, vice-president and manager of the Dain Manufacturing Co., a subsidiary of Deere and Company, passed away suddenly in his office on the morning of February 13.

Born November 28, 1885 at Chenoa, Illinois, he attended the University of Illinois and received his bachelor of science degree in mechanical engineering in 1910. After several months with the Republic Iron and Steel Co., in Moline, he joined the Deere organization and continued with it and various of its subsidiaries throughout his career. He was made superintendent of the Dain Mfg. Co. in 1913, and manager in 1917. He was elected to membership in the A.S.A.E. in 1920.

The **FOX** will give you all "3"



**T**HE FOX Pick-up Hay Chopper and Silage Harvester does the three toughest jobs on the farm—Haying, Forage Harvesting, and Silo Filling.

With the FOX the farm for the first time is properly mechanized because with the FOX method:

- you can mow, chop and load in one operation over 200 tons of grass silage a day.
- you can cut corn of any height, chop it into silage and load it into wagons ready for the silo, all in one operation.
- one man, with the FOX, can pick up, chop and load, ready for the mow or stack 2 tons of dry hay in 12 minutes.

The FOX is built by the Pioneers of Modern Forage Harvesting. WRITE US—we will be glad to tell you all about this marvelous machine.

*R. B. Kung*  
Secretary

## FOX RIVER TRACTOR COMPANY

Pioneers of Modern Forage Harvesting

1837 NORTH RANKIN STREET

APPLETON **FOX** WISCONSIN

The  
**FOX**

usually pays for itself in a short time, and unlike machines built down to a price, gives years of trouble-free service.



# Fencing FOR THE FUTURE!



The special construction of the PIONEER KNOT makes Continental Fence semi-flexible. It "gives" under pressure, then springs back straight.

● Better farming methods and permanent pasture programs will require new and better fence. Continental Fence has many features to give it longer life and greater strength. It is made of copper steel wire that carries a heavy, uniform zinc coating, **FLAME-SEALED** for extra protection against rust. Continental Fence with the PIONEER KNOT is semi-flexible to withstand crowding of livestock without folding or buckling of the stay wires. This knot will not unwrap and actually tightens under strain. Only Continental **FLAME-SEALED** Fence with the PIONEER KNOT can give you all these advantages.

PLAN NOW FOR THE FUTURE... WITH THESE FREE BOOKLETS



The Building Plan Service, the Grassland Farming Manual, and the 1947 Farm and Livestock Record Book will help you plan farm improvements. Write today.

**CONTINENTAL STEEL**  
**CONTINENTAL STEEL CORPORATION**  
GENERAL OFFICE: KOKOMO, INDIANA

PRODUCERS OF — 18 Types of Farm Fences, Posts, Gates, Barb Wire — 14 Styles of Steel Roofing and Siding, and Fittings — Nails, Staples, Lawn Fence, Wire Products

## Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Niels B. Anderson, instructor and research assistant in agricultural engineering, South Dakota College, Brookings, S. D.

Orville C. Baker, factory office training, Goodyear Tire & Rubber Co., Akron, Ohio. (Mail) YMCA, 80 West Center St.

Nathaniel H. Callard, in charge of rural electrification operations, industry sales, Westinghouse Electric Corp., East Pittsburgh, Pa.

Hubert M. Clark, vice-president in charge of engineering, Sherman Products, Inc., 3949 E. Nine Mile Road, Hazel Park, Mich.

Robert N. Craig, assistant professor of agricultural engineering, A. & M. College of Texas, College Station, Tex.

Graham F. Daniel, vice-president and manager, parts dept., Russell Daniel, Inc., 480 N. Thomas St., Athens, Ga.

Thomas L. Dobbins, farmer, Townsville, S. C.

Keith N. Gallagher, extension agricultural engineer, farm labor program, Cornell University. (Mail) Box 197, Spencer, N. Y.

Aylmer H. Gray, Jr., head, rural development dept., Southwestern Gas and Electric Co., Shreveport, La.

Robert B. Hedrick, drainage specialist, Soil Conservation Service, USDA. (Mail) Rosenberg, Tex.

Arthur Kramer, director, experimental laboratory, Puget Sound Power & Light Co. (Mail) Puyallup, Wash.

C. P. Merrick, Jr., extension specialist in drainage engineering, University of Maryland. (Mail) Denton, Md.

James H. Oliver, design engineer, farm industry development, General Electric Co. (Mail) R. R. No. 2, Ballston Spa, N. Y.

Paul J. Peterson, director, A/S Helbaek Maskinfabrik, Helbaek, Denmark.

John T. Phillips, Jr., vice-president and assistant manager, Lilliston Implement Co., Albany, Ga.

Sephaniah Reese, Jr., general manager, S. Reese Machine & Tool Works, 230 West Main St., Plymouth, Pa.

Elzo A. Schutt, draftsman, Starline, Inc., Harvard, Ill. (Mail) 100 N. Jefferson St.

Paul E. Schlessener, student in engineering college, University of Nebraska, Lincoln, Neb. (Mail) 348 North 14th St.

Leroy C. Shaw, farmer, R. R. No. 2, Box 146, Perkinston, Miss.

Ben C. Shipman, sales engineer, Rilco Laminated Products, Inc. (Mail) Box 418, Wilkes Barre, Pa.

H. H. Watson, standards engineer, General Electric Company. (Mail) 1285 Boston Ave., Bridgeport 2, Mass.

Thomas J. Wilson, manager of sales and engineering, C. A. McDade Co. (Mail) Mt. Royal Blvd., Glenshaw, Pa.

### TRANSFER OF GRADE

Russell E. Heston, agricultural engineer, Rural Electrification Administration, USDA. (Mail) 1069 27th St., Des Moines 11, Iowa. (Junior Member to Member)

Walter W. Hinz, instructor in agricultural engineering, State College of Washington, Pullman, Wash. (Mail) 1705 A St. (Junior Member to Member)

W. A. Junnila, agricultural engineer (BPISAE) U. S. Department of Agriculture. (Mail) Storrs, Conn. (Junior Member to Member)

William Kalbfleisch, agricultural engineer, Dominion Department of Agriculture. (Mail) Central Experimental Farm, Ottawa, Ont., Canada. (Junior Member to Member)

Lester F. Larsen, engineer in charge of tractor tests, agricultural engineering dept., College of Agriculture, Lincoln 1, Neb. (Associate to Member)

Charles E. Rice, agricultural engineer, Soil Conservation Service, USDA. (Mail) P. O. Box 210, Palestine, Tex. (Junior Member to Member)

Joe B. Richardson, associate professor of agricultural engineering, Clemson Agricultural College, Clemson, S. C. (Junior Member to Member)

Glenn E. Saba, agricultural sales engineer, Baldwin-Duckworth Div., Chain Belt Co., 309 Plainfield St., Springfield 2, Mass. (Junior Member to Member)

Samuel J. Sirebin, chief, soil survey section, Departamento de Edafologia, Instituto Experimental De Agricultura Y Zootecnia, El Valle, Caracas, Venezuela. (Junior Member to Member)

## NEW HELP FOR AMERICAN FARMERS



### ...The John Deere *Automatic* Baler

The new John Deere Automatic Baler is a farmer's dream come true. It picks up hay or straw from the windrow, bales it, and ties the bales securely with wire. One man bosses the whole job from the tractor seat.

The windrow is fed directly into the baling case. The bales are tied with a minimum of wire—no clipped ends are left in the field or bales to endanger livestock. Simple, sturdy, com-

pact construction assures years of satisfactory service.

The John Deere Automatic Baler makes haying a faster, easier, more profitable job. It is one of many new John Deere developments that promise a brighter future for farmers everywhere.

**John Deere**

MOLINE • ILLINOIS



## WISCONSIN-POWERED TILLIVATOR... for accurate Cultivation of Narrow Row Crops...

Powered by a single cylinder, Wisconsin Air-Cooled Engine, the Tillivator (made by Ariens Co., Brillion, Wis.) completely cuts and chops weeds, preventing them from growing again. Fully adjustable both for row widths and depth control.

This is another typical example of the effective application of Wisconsin Engine Power to the needs of agriculture. Wisconsin Air-Cooled Engines are available in single cylinder and V-type 4-cylinder models, in a power range of 2 to 30 hp.

Detailed data on request.

Most  
H.P. per  
pound

# WISCONSIN MOTOR

Corporation

MILWAUKEE 14, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines

## Your MOBILE Products Deserve the BEST WHEELS

for  
FARM

for  
INDUSTRY

**WE** EXTEND to all manufacturers of mobile farm equipment the full benefits of our capacity for designing, testing and producing wheels capable of satisfying, in full, the actual demands of any given range of field service. In many instances it may be possible to utilize **STANDARD WHEELS and HUBS**—thereby achieving economies and avoiding delays.

Send Your Wheel Problems to Us

**FRENCH & HECHT**  
DIVISION  
KELSEY-HAYES WHEEL COMPANY  
DAVENPORT  
IOWA

Wheel  
Builders

Since  
1888



## Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated.

Attention is invited to the desirability of checking on the housing situation when considering a new location.

POSITIONS OPEN: MAY—O-499, 503. JUNE—O-506. AUGUST—O-510, 511. SEPTEMBER—O-516, 520, 521. NOVEMBER—O-523. DECEMBER—O-526, 527, 531, 532. JANUARY—O-535. FEBRUARY—O-540, 541, 542.

POSITIONS WANTED: FEBRUARY—W-207, 254. APRIL—W-232, 237, 240, 276, 292. MAY—W-309, 312. JUNE—W-316, 320, 322. SEPTEMBER—W-337. NOVEMBER—W-355, 356, 358, 359. DECEMBER—W-361, 363, 365, 367. FEBRUARY—W-371, 373, 374.

### POSITIONS OPEN

**AGRICULTURAL ENGINEER** (instructor or assistant professor) for full time teaching, and possibly some research, in farm machinery, in southeastern land grant university. BS deg in agricultural engineering. Usual personal qualifications for college teaching. Nine months basis. Additional pay if summer teaching required. \$3000. O-543

**AGRICULTURAL ENGINEER**, for extension work with REA line-man on safety and job training, in north central state. BS deg in agricultural engineering, with good foundation in rural electrification. Experience in rural electric line building desirable. \$3300—\$3900, depending on qualifications. O-544

**AGRICULTURAL ENGINEER**, for laboratory and field testing of all forms of farm implements, by large distributor. Location, Chicago or vicinity. BS deg in agricultural engineering. Four or five years in testing all forms of farm implements, and preferably some experience in its design and production. Age, 30-35. Salary open. O-545

**AGRICULTURAL ENGINEER**, for design and development of agricultural implements and related items, with manufacturer in North Central area. BS or MS deg in agricultural engineering. Experience will be given consideration. Good opportunity for advancement. Age, 24-35. Salary open. O-546

**AGRICULTURAL ENGINEER** for designing steel farm structures, related equipment, packing and marketing buildings, livestock show and sale facilities, freezer locker plants, and grain elevators. BS deg in agricultural, civil, or architectural engineering, specializing in structures. Previous drafting experience desirable. Good opportunity for advancement. Age, under 30. Salary \$255 mon (min.) O-547

**AGRICULTURAL ENGINEERS** (3) for extension work in agricultural engineering in a district of 4 to 6 counties, in a northeastern state. BS deg in agricultural engineering, or in agriculture with a major in agricultural engineering. Farm background, teaching ability, ability to meet people and gain their confidence. Opportunity for advancement in either the extension service or the department of agricultural engineering. Salary open. O-548

### POSITIONS WANTED

**AGRICULTURAL ENGINEER** desires work in power and machinery or rural electrification field. BS deg in agricultural engineering, Virginia Polytechnic Institute, expected March 1947. Farm background. Enlisted and commissioned war service in Corps of Engineers. No physical defects. Available April 1. Single. Age 24. Salary open. W-375

**AGRICULTURAL ENGINEER** desires research in public service, or private industry; or college teaching or extension work. BS deg in agriculture, Bombay University, 1942. MS deg in agricultural engineering, Michigan State College, 1946. Experience in teaching, University of Bombay, six months; agricultural administrative work, Government of India, twenty-one months. No physical defects. Available on two weeks notice. Single. Age 25. Salary open. W-377

**AGRICULTURAL ENGINEER** desires work in research or design in farm machinery. BS deg in agricultural engineering, Kansas State College, 1943. One semester of graduate work. Commissioned war service in Army Ordnance. Nine months experience in experimental shop materials engineering, and research with farm equipment manufacturer. No physical defects. Available one month after acceptance. Married. Age 26. Salary open. W-378

**AGRICULTURAL ENGINEER** desires design work with farm machinery manufacturer. BS deg in agricultural engineering, University of Saskatchewan, expected May 1947. Farm background and summer experience in shipyard, as tractor operator on experimental farm, and in repair department of farm machinery manufacturer. No physical defects. Available July 1. Single. Age 23. Salary open. W-379

**AGRICULTURAL ENGINEER** desires development work in power and machinery or soil and water field, in private industry. BS deg in agriculture (major in agricultural engineering). Ohio State University, 1942. Farm background, enlisted and commissioned experience, Army Air Corps, work in school ground maintenance, landscape contracting, and test engineering. No physical defects. Available March 30. Married. Age 28. Salary \$275 per month. W-380

(Continued on page 128)

# ZINC

## protects Against RUST



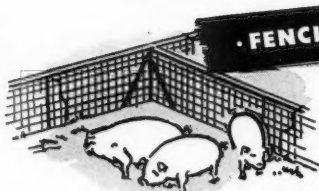
ROOFING  
SIDING

### GALVANIZING GUARDS THE FARM!

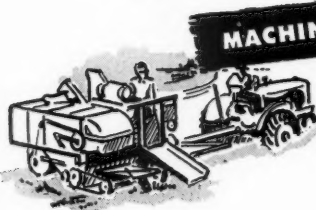
Farmers have long depended on GALVANIZING (ZINC-COATING) to protect iron and steel surfaces against costly rust. They know zinc gives double-protection—both by the coating itself and thru' electro-chemical rust-retarding action between the zinc and the surface it covers. As long as iron or steel is coated with zinc, it cannot rust. The heavier the coating, the longer the protection. For metal surfaces on the farm . . . it's the zinc that stops the rust!



STOCK TANKS



FENCING



MACHINERY

## FREE BOOKLETS

WRITE TODAY for these valuable booklets: (1) Repair Manual on Galvanized Roofing and Siding (2) Facts About Galvanized Sheets (3) Use Metallic Zinc Paint to Protect Metal Surfaces.

The "Seal of Quality", shown below is the farmer's guide to economy in buying galvanized sheets. Sheets bearing this Seal carry at least 2 oz. of Zinc per square foot!



# American Zinc Institute

Room 2607 - 35 East Wacker Drive, Chicago 1, Illinois

## Protecting Crops, Machinery, Homes **SISALKRAFT** Does It



On farms — like any other business — every dollar saved is that much profit. Wind, rain, sleet, snow — exposure of every kind — can do much damage to harvested crops, machinery, buildings. With Sisalkraft much of this loss can be avoided.

Sisalkraft is ideal for temporary silos — emergency storage of grain — covering hay stacks — protecting machinery — curing concrete — lining poultry houses — protecting the home — plus many other uses. Costs little. Tough, tear-resistant, and waterproof. Can be used again and again.



Sisalkraft is sold through lumber dealers everywhere. Write for folders on Sisalkraft's many farm uses.



### ... With the Help of GOOD FENCES

"Corn yielded only 30 bushels per acre when we moved on this farm 19 years ago. But after fencing the farm with woven wire, adding clover pasture to the rotation, and stocking the farm, crop yields began to improve. Last year, corn averaged well over 60 bushels per acre. The extra livestock we can now raise brings in a good income, too.

"We have found that rotated clover pasture and plenty of livestock is a practical way to build up the soil—and it helps cut down on fertilizer expense. All this would be impossible without good fences."

**KEYSTONE STEEL & WIRE CO.**  
PEORIA 7, ILLINOIS



## PROFESSIONAL DIRECTORY

**GEORGE R. SHIER ROBT. J. McCALL**

Professional Agricultural Engineering Services

Structures, Ventilation, Drying, Machinery Development and Sales Consultation, Engineering Design

Members A.S.A.E. Room 705, 8 E. Broad St., Columbus 15, Ohio

## FRANK J. ZINK ASSOCIATES

**Agricultural Engineers**

Consultants on product development, designs, research, market research, public relations

FELLOW A.S.A.E. Suite 4300, Board of Trade Bldg.  
MEMBER S.A.E. Telephone: Harrison 0723 Chicago 4, Illinois

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of \$1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

## PERSONNEL SERVICE BULLETIN

(Continued from page 126)

AGRICULTURAL ENGINEER desires sales, service, or public relations work in farm machinery field. BS deg in agricultural engineering, Michigan State College, 1946. Farm background, enlisted service in Army Air Corps, and three months training with farm machinery manufacturer. No physical defects. Married. Age 28. Salary \$3000. W-381

AGRICULTURAL ENGINEER desires sales work with private company serving agriculture. BS deg in agricultural engineering, Iowa State College, 1941. Farm background; one year executive training with farm equipment manufacturer; commissioned naval war service mostly as chief engineer of 55,000-hp destroyer power plant; 15 months writing technical overhaul and service manuals on farm tractors for manufacturer. No physical defects. Married. Age 28. Salary \$3600. W-382

## New Federal and State Bulletins

"Labor-Saving Equipment from Your Own Farm Shop" is the title of a series of farm-built plans prepared by R. S. Knight, extension agricultural engineer, Kansas State College. Numbers and titles of the series so far issued are as follows: (1) Tractor Mounted Post Hole Digger, (2) Stock Trailer, (3) Portable Grain Blower, (4) Home-made Bulldozer, (5) Fence Roller, (6) Rear-Mounted Post Hole Digger, (7) Ensilage Spreader, (8) Fertilizer Spreader, (9) Stalk Cutter, (10) Power Tractor Hoists, (11) Grain Trailer, (12) Manure Loader (Hydraulic Type), (13) Manure Loader, (14) Two-Wheel Power Tilting Trailer, (15) Roller-Packer, (16) Lightweight Hay Elevator, (17) Portable Hay Elevator, (18) Combination Hay and Grain Elevator, (19) Implement Trailer, (20) Tractor Buzz Saw, (21) Rear-Mounted Tractor Hay Buck, (22) Transport Type Auto Hay Buck, (23) Tractor Buzz Saw (Rolling Table), (24) Tractor Buck Rake, (25) Auto Hay Buck, (26) Auger Grain Elevator, (27) Post Hole Digger on Loader Frame, (28) Bulldozer Blade for Manure Loader, (29) Light Two-Wheeled Flat Bed Trailer, (30) Combine Tank Grain Trailer, (31) Sweet Clover Windrower, (32) Truck-Mounted Grain Blower, (33) Four-Wheeled Trailer (Wagon Steering), (34) Four-Wheel Trailer (Auto Steering), (35) Portable Welder, (36) Combine Platform Lift, (37) Air Compressor, (38) Purebred Cattle Stocks, (39) Bale Pickup, (40) Field Ensilage Cutter.

"Management and Housing of Dairy Herd Sires", of which M. G. Huber and Dale E. Kirk, respectively extension agricultural engineer and assistant agricultural engineer in the experiment station, are authors, is the title of Extension Bulletin 661 issued by the Oregon State College.

"Making and Feeding Grass and Legume Silage" by M. G. Huber, extension agricultural engineer, is the title of Bulletin 669 issued by Oregon State College.

"Septic Tanks" by M. G. Huber, extension agricultural engineer, is the title of Bulletin 670 issued by Oregon State College.

"Fire Fighting on Farms", by A. T. Holman, U. S. Department of Agriculture Miscellaneous Publication No. 612. October, 1946.

## Forced Ventilation of Stored Vegetables

AT THE Ohio Agricultural Experiment Station an exploratory test for aerating a large pile of turnips (2300 bu) was made, with a blower arrangement similar to that used for drying hay in the mow. There was no difficulty in preventing an undue rise in temperature in the pile, although free circulation of air was interfered with in spots by earth and trash. The experience indicates the feasibility of storing root crops in large piles.